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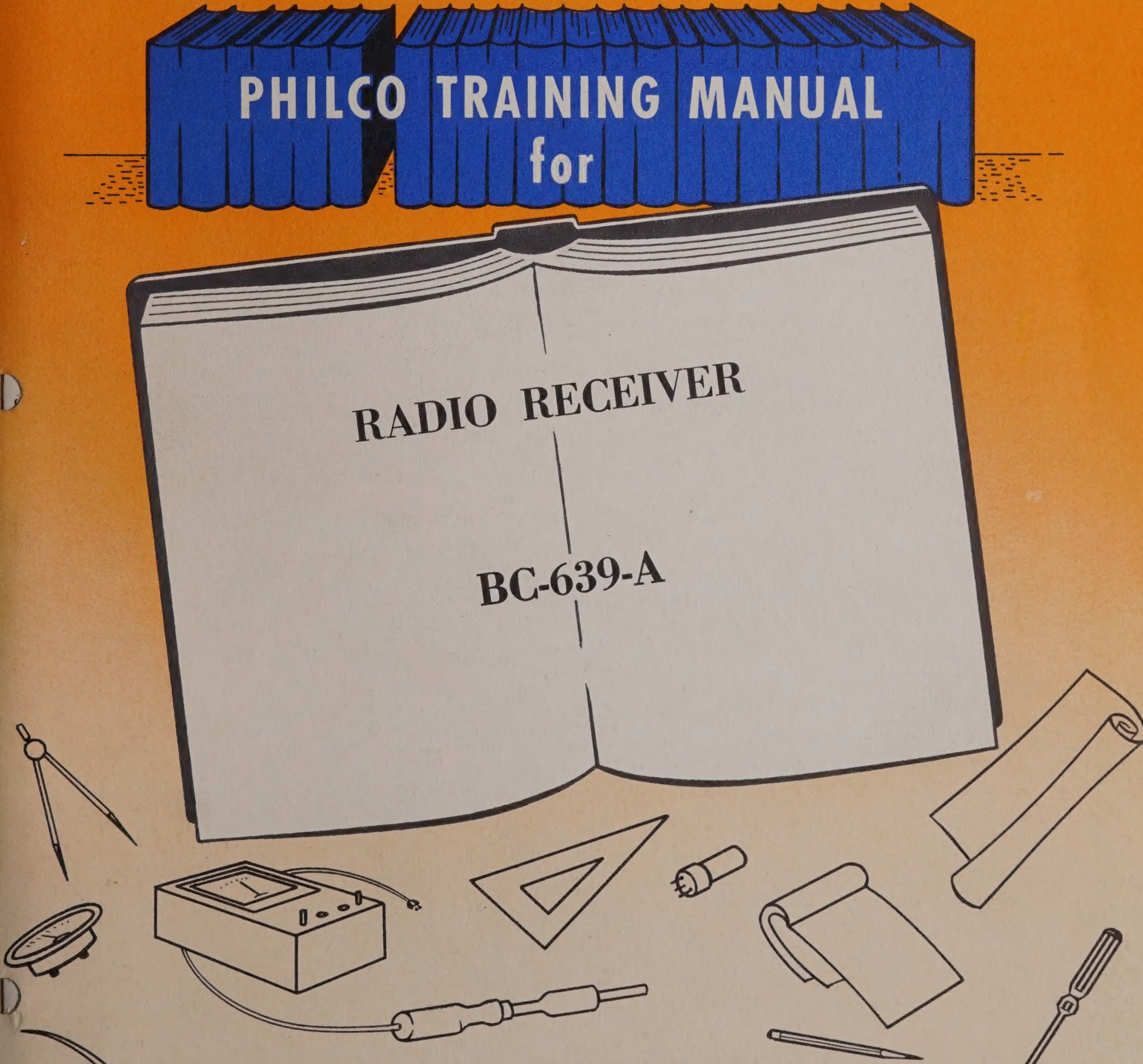

PHILCO TRAINING MANUAL
for

RADIO RECEIVER

BC-639-A

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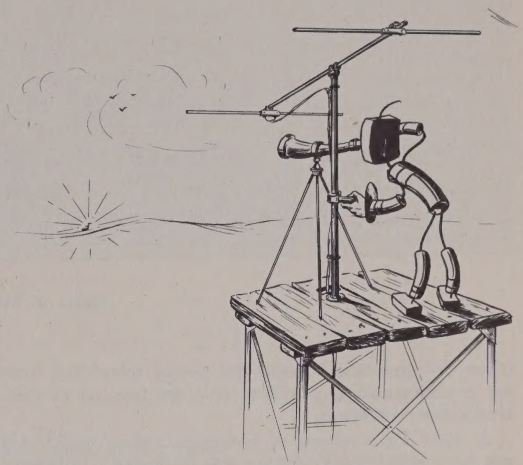
LECTURE No. 1

INTRODUCTORY INFORMATION



Radio Receiver BC-639-A is a v-h-f (very-high-frequency) radio receiver, which is primarily intended to be used as part of a fixed ground or mobile radiophone communication system. It is also used for aircraft direction finding and as part of v-h-f fighter-control equipment, such as the SCR563, SCR564, etc.

Before v-h-f equipment of this type was developed, radio equipment which operated at much lower frequencies and ordinary telephones were used for communication purposes.

The low-frequency radio equipment, although excellent for many communication purposes, does have a number of disadvantages. Atmospheric static and certain conditions of the ionosphere that cause fluctuating signals often make reliable reception impossible. It is also extremely difficult to direct, or beam, the transmitted signal along a narrow path, and thereby limit its coverage, because of the great difficulties encountered in installing the necessary special-type antennas. Beaming the signal along a narrow path is very desirable in military use, since by limiting the area of signal coverage, the interception of messages by an enemy will be more difficult and will depend not only upon his knowledge of the frequency which is being used, but also upon his position relative to the narrow signal path.

Telephones used for communication purposes do not have the disadvantages mentioned above. There are other difficulties, however, such as telephone line installation problems and telephone line losses. Telephone line installation problems, especially those due to rough terrain, have no simple solution and, therefore, are considered to be the major disadvantage of this type of communication system.

Telephone line losses, however, can be quite easily overcome by the use of auxiliary equipment, but it is not always practical to use this equipment, especially when installations are not of a permanent nature.

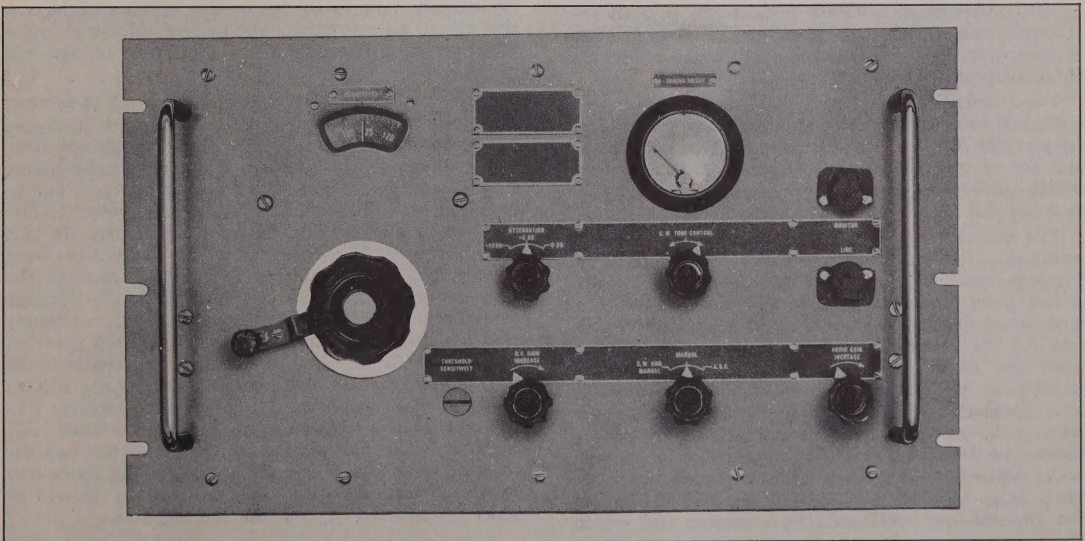


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Figure 1. Radio Receiver BC-639-A

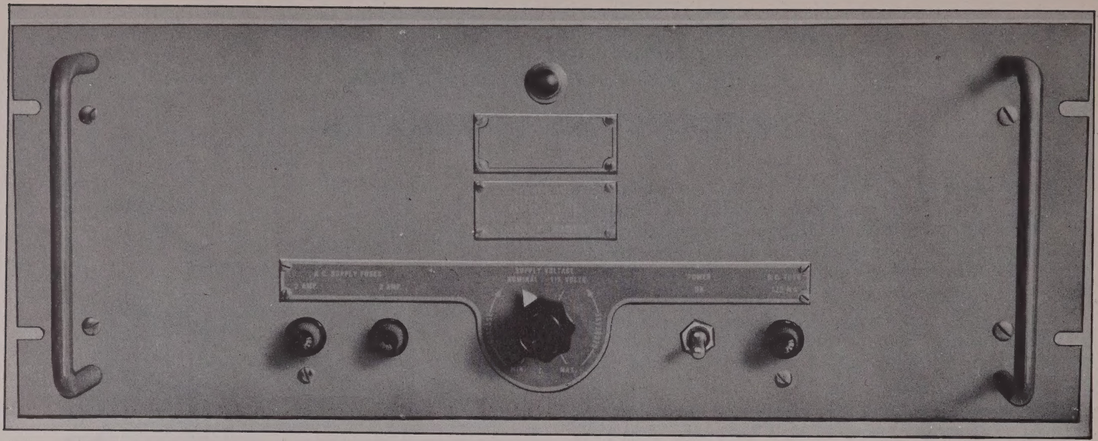

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Figure 2. Rectifier Unit RA-42-B

Thus, for practical reasons the use of telephone lines for communication purposes is often limited to relatively short distances.

A need for a means of communications which did not have these disadvantages was indicated. This need led to the development of v-h-f equipment, such as the BC-639-A, AN/ARC-1, AN/ARC-3, AN/TRC-7, etc., which operate at frequencies of 100 to 156 megacycles.

It was found that equipment designed to operate at these very high frequencies could be depended upon for reliable communications 24 hours a day. Atmospheric static and varying conditions of the ionosphere have very little effect upon communications at these frequencies.

The problems of antenna installation at both the receiving and transmitting sites were relatively simple as compared to the problems of installing antennas for low-frequency communication.

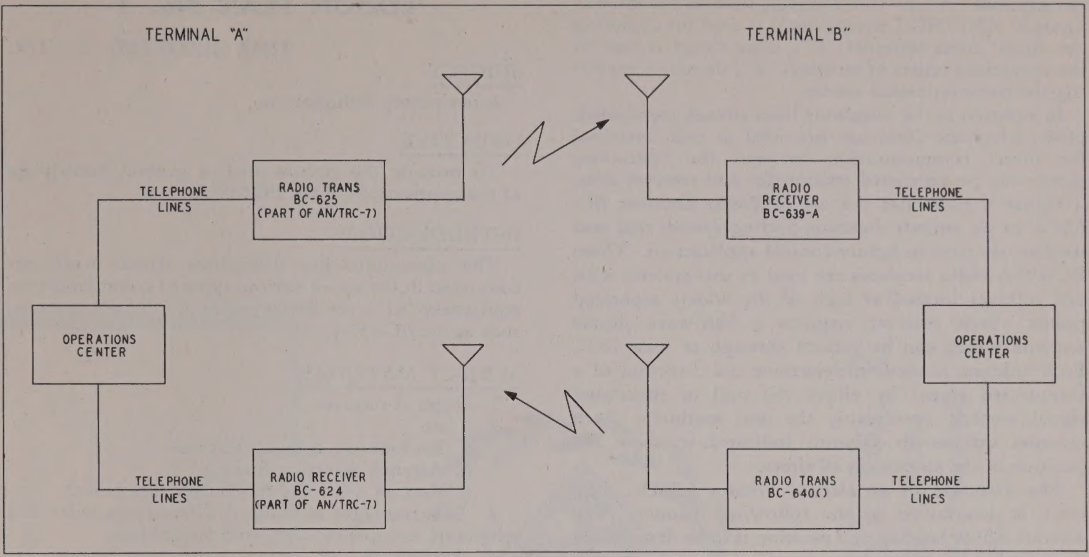
V-h-f antennas are usually half-wave dipoles that are much smaller physically than antennas used at low frequencies. Their small size makes easy the installation and use of special, efficient, directive antenna arrays, which increase the range of communications and concentrate the signal into a very narrow beam.

The use of very high frequencies for reliable communication is often limited to relatively short distances (approximately line-of-sight) by factors such as transmitter power, antenna height, and antenna location. The actual distance covered may be regulated by controlling the antenna height and orientation. When both the receiving and transmitting antennas are located on very high hills, reliable communication over distances of 100 miles or more is not uncommon; when both antennas are of the same height and are located on level land, reliable communication is generally limited to a maximum distance of about 30 miles. Hills, large buildings, etc. which are located between the transmitting and receiving antennas and which are higher than both antennas will prevent the signal from passing or severely attenuate it. In some cases, however, normal communication from one side of a hill, or other intervening object, to the other side may be accomplished by utilizing the reflection properties of the v-h-f signal. By directing the transmitted signal toward another object (hill, building, etc.) which will reflect the signal in the proper direction, it is possible to pass the signal around the intervening object to the desired point on the other side.

By properly orienting the antenna, hills, large buildings, etc. which prevent the passage of v-h-f signals, may be used to good advantage at the transmitter site for minimizing the signal strength in a particular direction. This makes it possible to minimize mutual interference between stations which operate on the same frequency and which are located within communication distance of one another, and in military use, to minimize the chances of having the signal intercepted by the enemy. However, complete freedom from interception cannot be assumed at any time.

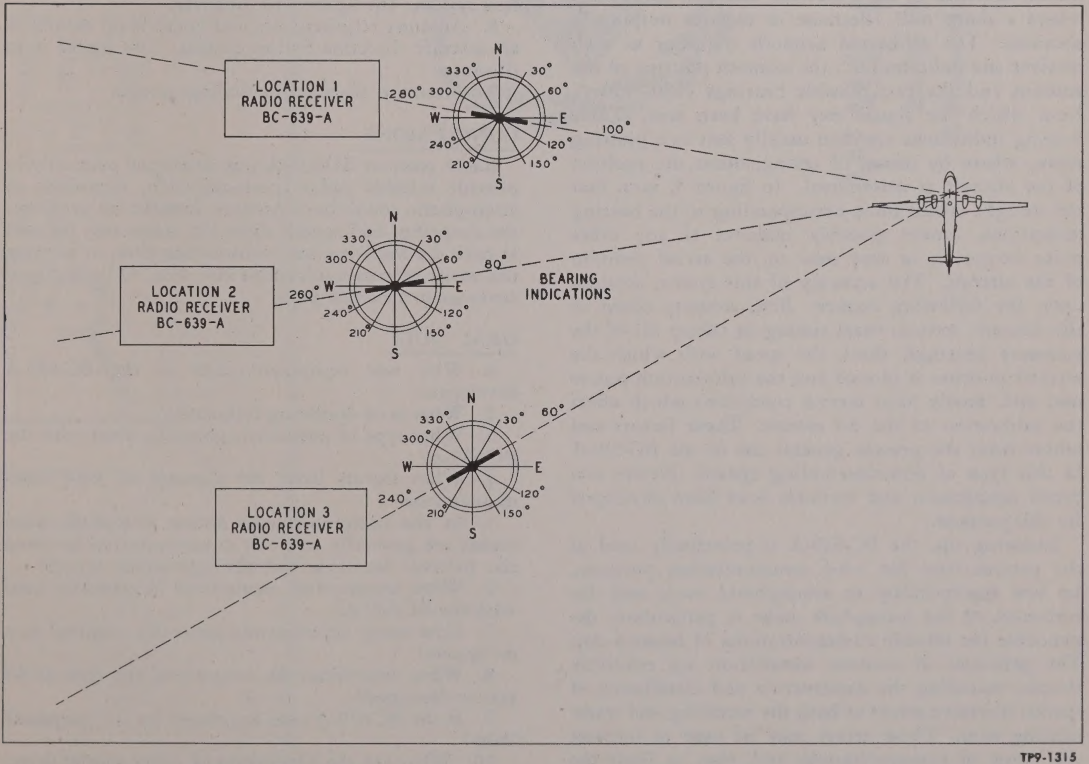
Radio Receiver BC-639-A and Radio Transmitter BC-640-( ) are generally used together as a single-channel terminal station of a v-h-f radio-phone communications system. Figure 3 illustrates a radio-phone communication system which uses these two equipments, other v-h-f communications equipment (AN/-TRC-7), and telephone distributing circuits. In this system, the signal originating at the operations center of terminal "A" is sent over telephone lines to the transmitter site, which is usually located some distance away from the operations center. At the transmitter site, a v-h-f transmitter, such as the BC-625 (part of the AN/TRC-7 equipment), is used for transmitting the signal from a directive antenna to the distant terminal "B". At terminal "B", Radio Receiver BC-639-A is used to receive the signal from Terminal "A". This signal is then either monitored at the receiver location or sent over telephone lines to the operations center of terminal "B", which is usually located at some distance away from the receiver site.

A signal in the opposite direction follows a similar path, except in this case v-h-f Radio Transmitter BC-640 is used to transmit the signal to terminal "A".


TERMINAL "A"
TERMINAL "B"
TELEPHONE LINES
RADIO TRANS BC-625 (PART OF AN/TRC-7)
RADIO RECEIVER BC-639-A
TELEPHONE LINES
OPERATIONS CENTER
OPERATIONS CENTER
TELEPHONE LINES
RADIO RECEIVER BC-624 (PART OF AN/TRC-7)
RADIO TRANS BC-640()
TELEPHONE LINES

TP9-1314

Figure 3. Block Diagram of Radiophone Communications System


LOCATION 1 RADIO RECEIVER BC-639-A
280°
100°
N
330°
30°
300°
60°
W
E
240°
120°
210°
150°
S
LOCATION 2 RADIO RECEIVER BC-639-A
260°
80°
BEARING INDICATIONS
LOCATION 3 RADIO RECEIVER BC-639-A
240°
60°

TP9-1315

Figure 4. Diagram of an Aircraft Direction-Finding System

At terminal "A", a v-h-f receiver, such as the BC-624 (part of AN/TRC-7 equipment), is used for receiving the signal from terminal "B". This signal is sent to the operations center of terminal "A", thereby completing the communication system.

In addition to the telephone lines already mentioned, other telephone lines are provided at each terminal for direct communication between the operations center and its associated transmitter and receiver sites.

Figure 4 illustrates the use of Radio Receiver BC-639-A in an aircraft direction-finding system that was used at one time in fighter-control applications. Three BC-639-A radio receivers are used in this system, with one receiver located at each of the widely separated points. Each receiver requires a half-wave dipole antenna which can be rotated through at least 180°. Each antenna is used to determine the direction of a transmitted signal by either the null or maximum signal method (preferably the null method). Each antenna utilizes an azimuth indicator to show the position of the antenna at all times.

The direction of an aircraft (motor vehicle, ship, etc.) is determined in the following manner: The aircraft whose bearing and position is to be determined (see figure 4) transmits a signal of the proper frequency at regularly spaced intervals. This signal is received by each of the BC-639-A receivers, and its direction immediately determined by rotating the special antenna, at each receiver location, to a point where a sharp null (decrease in receiver output) is obtained. The calibrated azimuth indicator at each receiver site indicates both the azimuth position of the antenna and the two possible bearings (180° apart) from which the signal may have been sent. These bearing indications are then usually sent to a plotting room, where by means of triangulation the position of the aircraft is determined. In figure 4, note that the straight dotted lines, corresponding to the bearing indications, cannot possibly intersect at any other point except at, or very near to, the actual position of the aircraft. The accuracy of this system depends upon the following factors: first, constant speed of the aircraft; second, exact timing in taking all of the necessary bearings; third, the speed with which the aircraft position is plotted and the information put to use; and, finally local terrain conditions which affect the calibration of the d-f system. These factors and others limit the present general use of the BC-639-A in this type of direction-finding system. Newer and better equipments and methods have been developed for this purpose.

Summing up, the BC-639-A is principally used at the present time for v-h-f communication purposes. Its low susceptibility to atmospheric static and disturbances of the ionosphere make it particularly dependable for reliable communications 24 hours a day. The problems of antenna installation are relatively simple, including the construction and installation of special directive arrays at both the receiving and transmitting sites. These arrays may be used to increase the range of communications and, also, to limit the signal coverage to a very narrow path, or beam.

LESSON PLAN No. 1

TIME ALLOTTED: 1/3 HR.

SUBJECT

Introductory information.

OBJECTIVE

To provide the trainee with a general knowledge of the applications of the BC-639-A.

INTRODUCTION

The communication difficulties which were encountered in the use of various types of communication equipment led to the development of v-h-f equipments, such as the BC-639-A.

SUBJECT MATERIAL

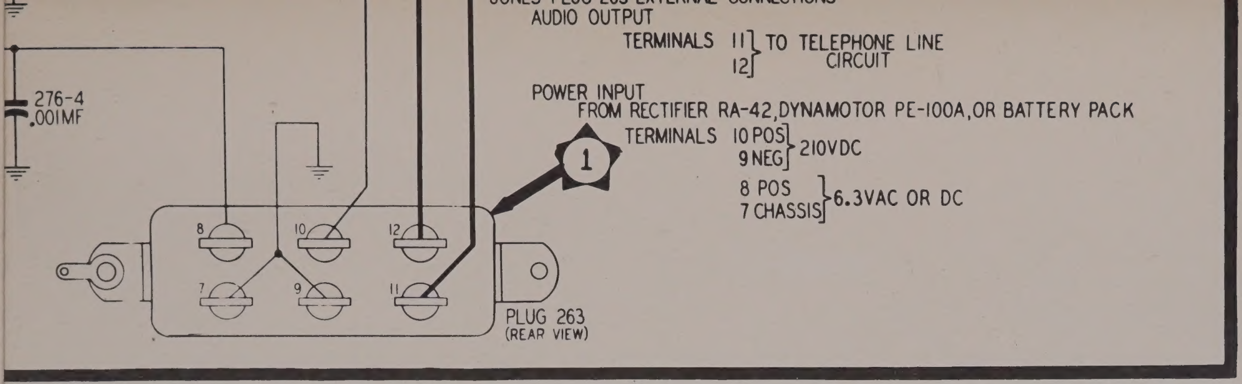
1. Type of receiver.
2. Uses.
   a. Radiophone communication.
   b. Aircraft direction-finding.
   c. Part of v-h-f fighter-control equipment.
3. Disadvantages of using low-frequency-radio and telephone equipments for communications.
4. Advantages of using v-h-f equipment for communications.
5. Limitations of v-h-f communications.
6. Using the limiting factors of v-h-f advantageously.
7. Operational details of a radio-phone communication system. Use figure 3 to illustrate.
8. Antenna requirements and operational details of an aircraft direction-finding-system. Use figure 4 to illustrate.
9. Accuracy of direction-finding system.

CONCLUSIONS

Radio receiver BC-639-A was developed primarily to provide reliable radio communication, regardless of atmospheric conditions. Antenna installation problems are simplified and special directive arrays may be used at both the receiving and transmitting sites, to increase the range of communications and, also, to limit signal coverage to a narrow path.

ORAL QUIZ

1. Why was equipment such as the BC-639-A developed?
2. What is its operating frequency?
3. What type of antenna is generally used with the BC-639-A?
4. What factors limit the distance of v-h-f communications?
5. In the communications system described, what means are generally used for communication between the receiver location, and the operations center?
6. What transmitting equipment is generally used with the BC-639-A?
7. How many receivers are generally required in a d-f system?
8. What determines the accuracy of the type of d-f system described?
9. Is the BC-639-A used at present for d-f purposes? Why?
10. What are the advantages of using special directive antenna arrays?


AUDIO OUTPUT
TERMINALS 11, 12 TO TELEPHONE LINE CIRCUIT
POWER INPUT
FROM RECTIFIER RA-42, DYNAMOTOR PE-100A, OR BATTERY PACK
TERMINALS 10 POS, 9 NEG 210VDC
8 POS, 7 CHASSIS 6.3VAC OR DC
1
276-4
.001MF
8
10
12
7
9
11
PLUG 263
(REAR VIEW)

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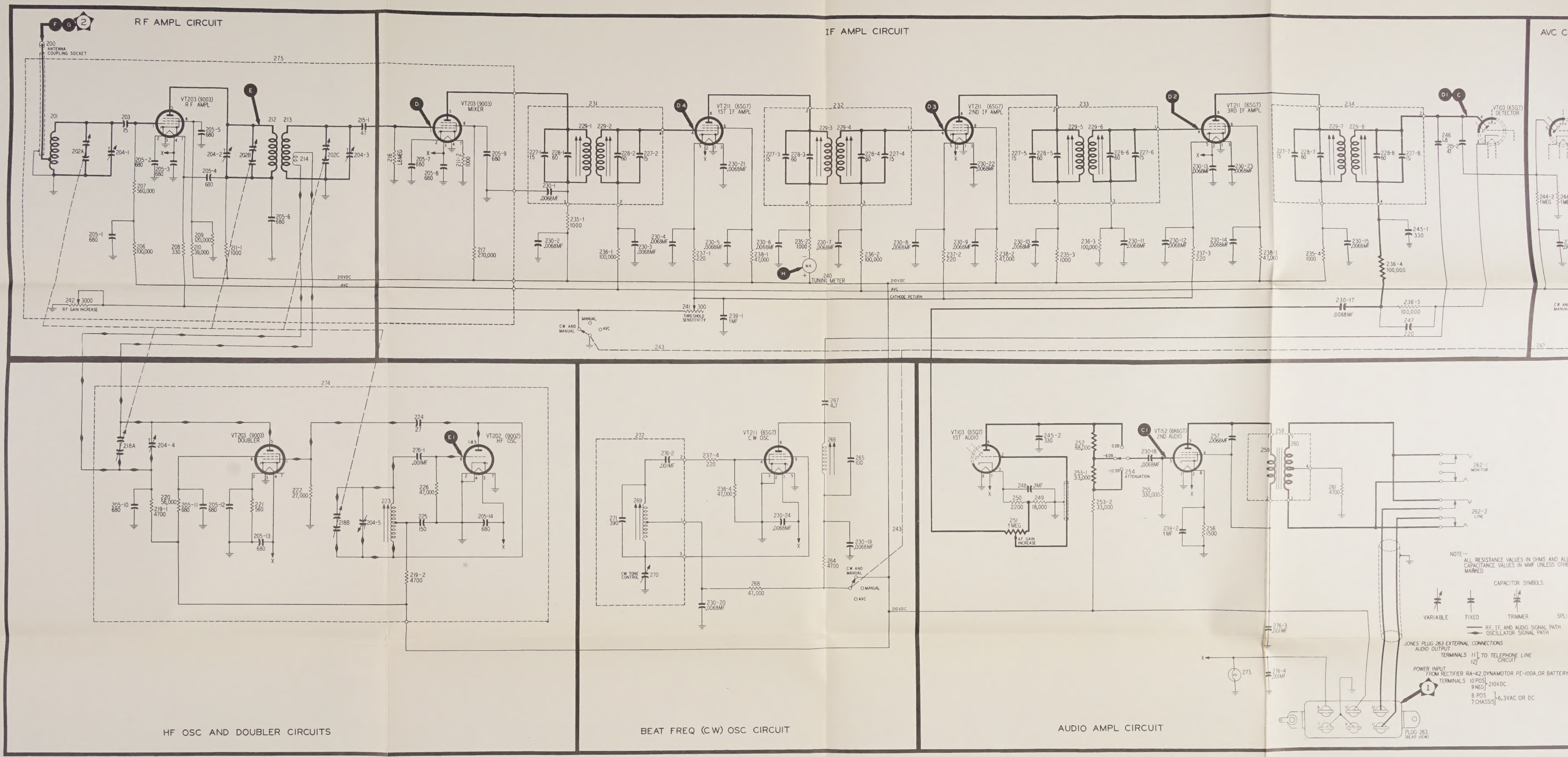
WALL CHART No. 2

Radio Receiver BC-639-A, Schematic Diagram, Showing Test Points.


RF AMPL CIRCUIT
IF AMPL CIRCUIT
AVC C
HF OSC AND DOUBLER CIRCUITS
BEAT FREQ (CW) OSC CIRCUIT
AUDIO AMPL CIRCUIT
200 ANTENNA COUPLING SOCKET
VT203 (9003) RF AMPL
VT203 (9003) MIXER
VT211 (6SG7) 1ST IF AMPL
VT211 (6SG7) 2ND IF AMPL
VT211 (6SG7) 3RD IF AMPL
VT103 (6SQ7) DETECTOR
VT203 (9003) DOUBLER
VT202 (9002) HF OSC
VT211 (6SG7) C W OSC
VT103 (6SQ7) 1ST AUDIO
VT152 (6K6GT) 2ND AUDIO
242 3000 RF GAIN INCREASE
240 TUNING METER
241 300 THRESHOLD SENSITIVITY
MANUAL
CW AND MANUAL
AVC
210VDC
CATHODE RETURN
CW TONE CONTROL
251 1 MEG AF GAIN INCREASE
254 ATTENUATION
262-1 MONITOR
262-2 LINE
PLUG 263 (REAR VIEW)
NOTE:-
ALL RESISTANCE VALUES IN OHMS AND ALL
CAPACITANCE VALUES IN MMF UNLESS OTHE
MARKED
CAPACITOR SYMBOLS
VARIABLE
FIXED
TRIMMER
SPLI
RF, IF, AND AUDIO SIGNAL PATH
OSCILLATOR SIGNAL PATH
JONES PLUG 263 EXTERNAL CONNECTIONS
AUDIO OUTPUT
TERMINALS 11, 12 TO TELEPHONE LINE CIRCUIT
POWER INPUT
FROM RECTIFIER RA-42, DYNAMOTOR PE-100A, OR BATTERY
TERMINALS 10 POS, 9 NEG 210VDC
8 POS, 7 CHASSIS 6.3VAC OR DC

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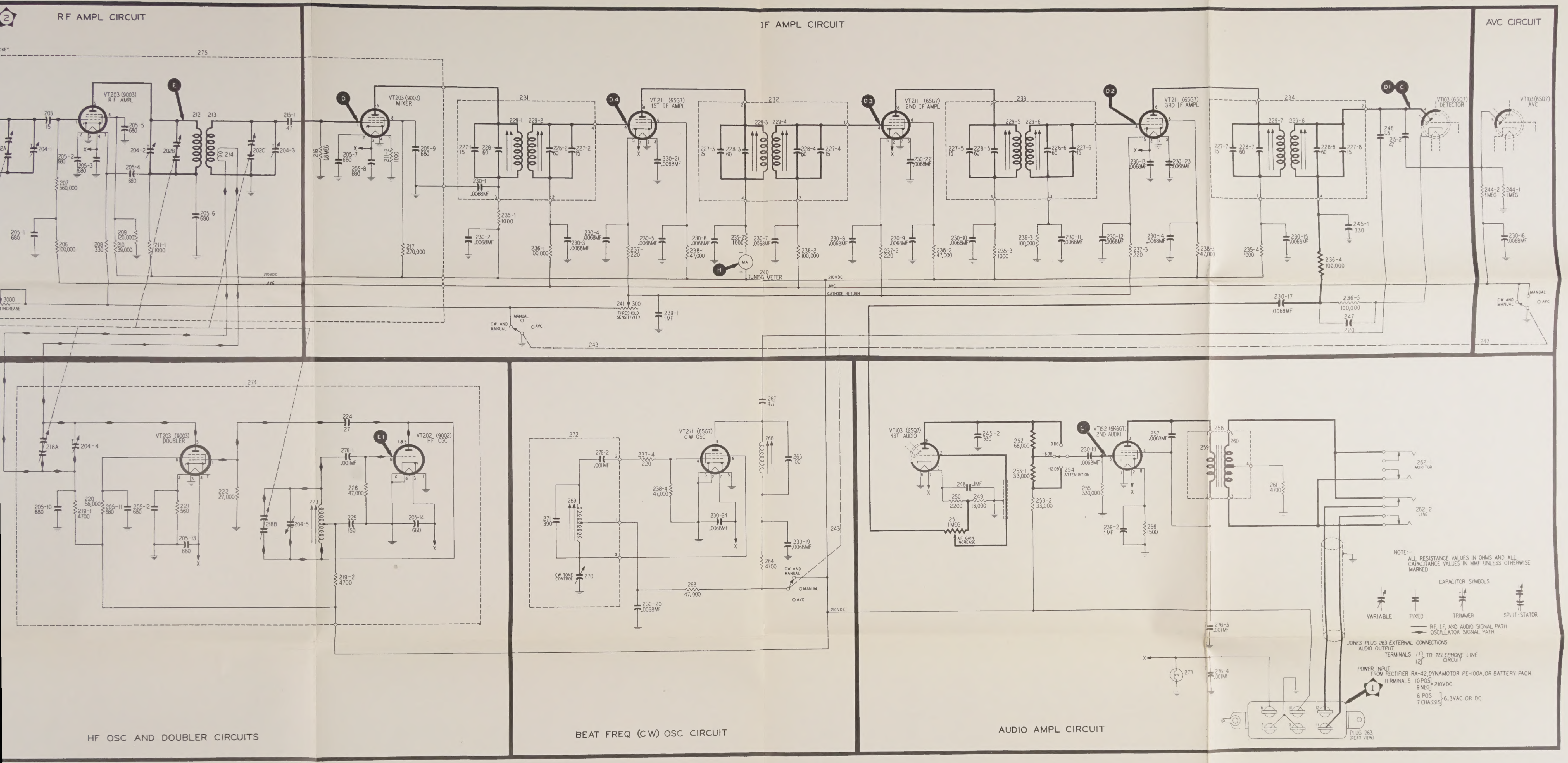
WALL CHART

Radio Receiver BC-63
Schematic Diagram, Sh
Test Points.


RF AMPL CIRCUIT
IF AMPL CIRCUIT
AVC CIRCUIT
HF OSC AND DOUBLER CIRCUITS
BEAT FREQ (CW) OSC CIRCUIT
AUDIO AMPL CIRCUIT
VT203 (9003) RF AMPL
VT203 (9003) MIXER
VT211 (6SG7) 1ST IF AMPL
VT211 (6SG7) 2ND IF AMPL
VT211 (6SG7) 3RD IF AMPL
VT103 (6SQ7) DETECTOR
VT103 (6SQ7) AVC
VT203 (9003) DOUBLER
VT202 (9002) HF OSC
VT211 (6SG7) CW OSC
VT103 (6SQ7) 1ST AUDIO
VT152 (6K6GT) 2ND AUDIO
240 TUNING METER
241 300 THRESHOLD SENSITIVITY
CW AND MANUAL
MANUAL
AVC
210VDC
CATHODE RETURN
CW TONE CONTROL 270
251 1MEG AF GAIN INCREASE
254 ATTENUATION
262-1 MONITOR
262-2 LINE
PLUG 263 (REAR VIEW)
VARIABLE
FIXED
TRIMMER
SPLIT-STATOR
RF, IF, AND AUDIO SIGNAL PATH
OSCILLATOR SIGNAL PATH

NOTE:—
ALL RESISTANCE VALUES IN OHMS AND ALL CAPACITANCE VALUES IN MMF UNLESS OTHERWISE MARKED

CAPACITOR SYMBOLS

JONES PLUG 263 EXTERNAL CONNECTIONS
AUDIO OUTPUT
TERMINALS 11, 12 } TO TELEPHONE LINE CIRCUIT
POWER INPUT
FROM RECTIFIER RA-42, DYNAMOTOR PE-100A, OR BATTERY PACK
TERMINALS 10 POS, 9 NEG } 210VDC
8 POS, 7 CHASSIS } 6.3VAC OR DC

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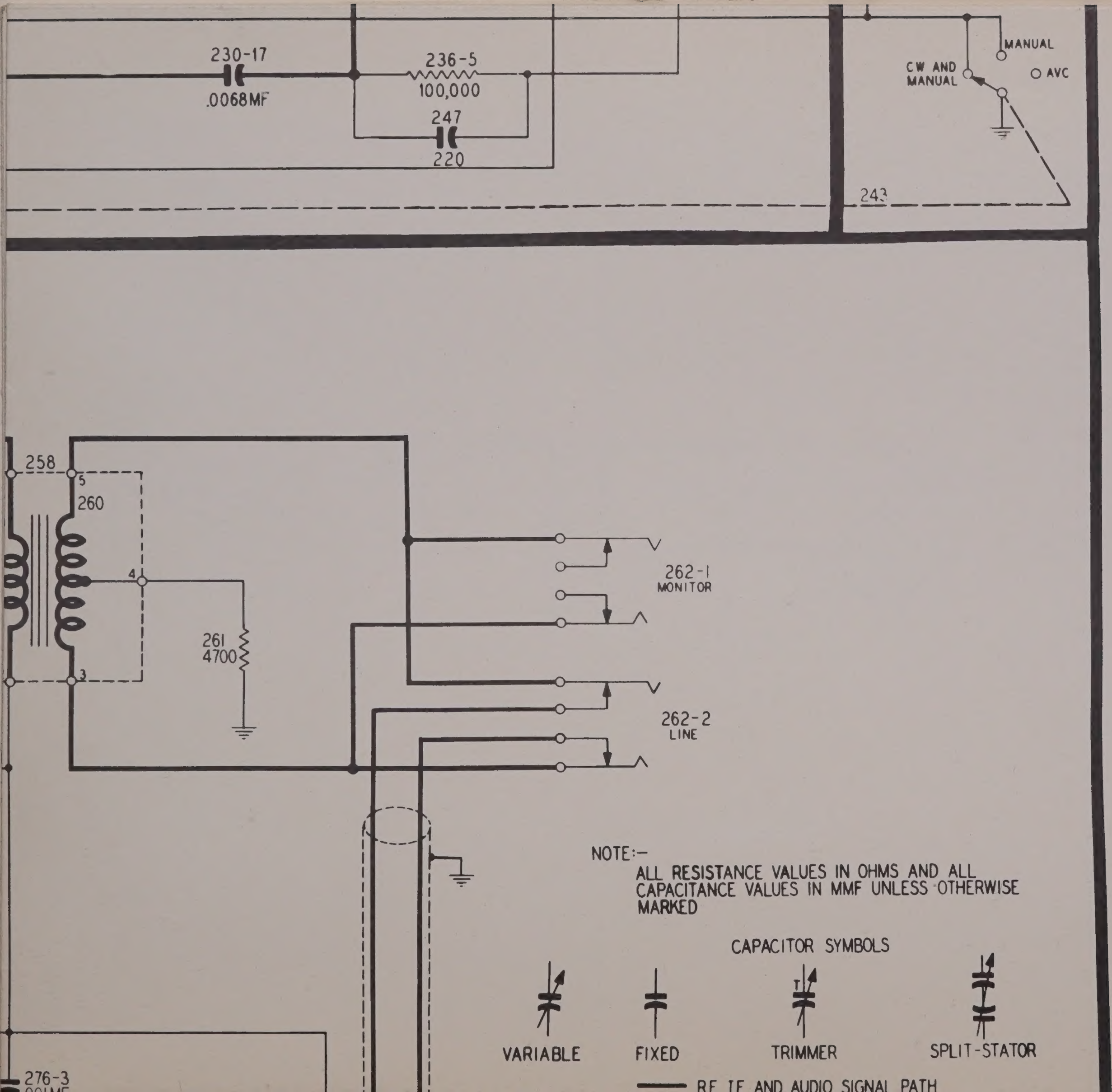
WALL CHART No. 2

Radio Receiver BC-639-A, Schematic Diagram, Showing Test Points.


230-17
.0068MF
236-5
100,000
247
220
MANUAL
CW AND MANUAL
O AVC
243
258
5
260
4
3
261
4700
262-1
MONITOR
262-2
LINE
276-3

NOTE:-
ALL RESISTANCE VALUES IN OHMS AND ALL CAPACITANCE VALUES IN MMF UNLESS OTHERWISE MARKED

CAPACITOR SYMBOLS

VARIABLE
FIXED
TRIMMER
SPLIT-STATOR

RF, IF AND AUDIO SIGNAL PATH

ANSWER AND TROUBLE-SHOOTING SUPPLEMENTS FOR RADIO RECEIVER BC-639-A

ANSWER SUPPLEMENT

EXAMINATION NO. 1, PART I

1. b.
2. c.
3. c.
4. b.
5. d.
6. c.
7. d.
8. b.
9. d.
10. b.
11. a.
12. b.
13. a.
14. b.
15. b.

16. The advantages of v-h-f communications over l-f communications are:

a. Low susceptibility to atmospheric static and varying conditions of the ionosphere.

b. More reliable for communications over a 24-hour period.

c. Ease in installing both receiving and transmitting antennas.

d. Ease in constructing and installing special highly directive antenna arrays.

17. The purpose of the ATTENUATION control is to provide a fixed loss by means of which the receiver output is reduced either 6 db or 12 db as required for special receiver applications.

18. Refer to figure 15.

19. The THRESHOLD SENSITIVITY control is set for normal receiver operation as follows:

a. Set the C.W. AND MANUAL-MANUAL-A.V.C. switch to MANUAL.
b. Set the R.F. GAIN INCREASE control to its maximum clockwise position.
c. Disconnect the antenna and short out the receiver antenna-coupling socket to the chassis.
d. Adjust the THRESHOLD SENSITIVITY control for a TUNING METER reading of 5 ma.

20. When the receiver is operated with the a-v-c circuit in use, the TUNING METER indication decreases as the receiver is tuned to the incoming signal and is a minimum when the receiver is accurately tuned. Thus by tuning the receiver for minimum TUNING METER indication, accurate tuning is accomplished.

EXAMINATION NO. 1, PART II

21. a.
22. b.
23. b.
24. a.
25. d.
26. b.
27. c.
28. a.
29. c.
30. a.

31. In the C.W. AND MANUAL and MANUAL positions of the C.W. AND MANUAL-MANUAL-A.V.C. switch, the R.F. GAIN INCREASE control determines the value of bias voltage on the 1st i-f-amplifier tube. Since the TUNING METER indicates the plate current of this tube, any change in the grid bias will cause a change in the TUNING METER reading.

32. The factors which determine the accuracy of the MEGACYCLES dial reading are:

a. Tuning-mechanism adjustments.
b. H-f-oscillator alignment.
c. I-f-amplifier alignment.

33. The higher the intermediate frequency used in a receiver, the greater the separation between the desired-signal frequency and the image-signal frequency, and the less the response of the receiver selector circuits to the image frequency. Thus a high i-f improves the image rejection.

34. To locate an insensitive i-f stage, connect a signal generator, with a 12-mc. output, progressively to each i-f stage, at test points D2 , D3 , D4 , and D . Adjust the generator output for a known output level at each test point. If the signal applied at a given test point does not produce the required receiver output, the i-f stage checked by that test point is insensitive.

35. The detector circuit rectifies the i-f signal and eliminates the undesired components from the rectified signal.

FINAL EXAMINATION, PART I

1. c.
2. d.
3. a.
4. d.
5. d.
6. a.
7. c.
8. c.
9. a.
10. b.
11. a.
12. d.
13. a.

14. c.
15. a.
16. a.
17. c.
18. b.
19. a.
20. c.
21. Refer to figure 15.
22. Refer to figure 15.

23. Test point 1 is used in checking the over-all operation of the power-supply circuit and distribution network. Test point 2 is used in checking the over-all operation of the receiver.

Whenever the indications obtained at test point 1 are abnormal, test points Ⓐ and Ⓑ are used in checking the separate sections of the power-supply circuit. Test point Ⓐ is used in checking the filament-supply section, and test point Ⓑ in checking the B-voltage supply section.

Whenever the indications obtained at test point 2 are abnormal, test points Ⓒ, Ⓓ, Ⓔ, Ⓕ, Ⓖ, and Ⓗ are used in checking the separate circuits which make up the receiver. Test point Ⓒ is used in checking the audio-amplifier circuit, and test point Ⓓ in checking the i-f-amplifier circuit and the amplifying portion of the mixer tube. Test point Ⓔ is used in checking the mixer, doubler, and h-f-oscillator circuit, and test point Ⓕ in checking the r-f-amplifier circuit. Test point Ⓖ is used in checking the beat-frequency (c-w) oscillator circuit, and test point Ⓗ in checking the a-v-c circuit.

24. A fixed negative voltage on the a-v-c diode plate of the detector-a.v.c.-1st audio amplifier tube prevents the a-v-c diode from conducting and producing the a-v-c voltage, which is used in controlling the gain of the circuits.

25. With the receiver set for manual operation, and for maximum sensitivity, the output of a signal generator, modulated 30% at 1000 cycles, is introduced into the receiver. The output of the signal generator is adjusted to produce a receiver output of 10 milliwatts. The signal-generator modulation is switched off and the receiver sensitivity is adjusted, by means of the R.F. GAIN INCREASE control, for a receiver output of one milliwatt. The above procedure is repeated until the receiver output for a modulated signal is ten times the output for an unmodulated signal.

FINAL EXAMINATION, PART II

26. b.
27. c.
28. d.
29. c.
30. b.
31. a.
32. b.
33. a.
34. c.
35. b.
36. c.
37. b.
38. d.
39. d.
40. a.
41. d.
42. b.
43. a.
44. c.
45. d.

46. A-v-c voltage is produced by the a-v-c circuit when the i-f signal applied to the a-v-c diode plate of the detector-a.v.c.-1st audio amplifier tube 6SQ7 is of sufficient strength to overcome the delay bias on the a-v-c diode. When the signal is strong enough, the a-v-c diode will conduct and rectify the i-f signal, causing a unidirectional current to flow through the a-v-c load resistor 244-1. This current flow produces the a-v-c voltage, which when properly filtered is applied as a bias voltage to the r-f-amplifier tube and the 1st and 2nd i-f-amplifier tubes for controlling the gain of these stages.

47. Resistor 244-2 and capacitor 230-16 are used together as a filter to eliminate the undesirable components of the a-v-c voltage, leaving only a d-c voltage which varies in amplitude with the average amplitude of the incoming signal.

48. Capacitor 230-19 provides the beat-frequency (c-w) oscillator plate circuit with a low-impedance path to ground, and in conjunction with resistor 264 serves as a filter for keeping the beat-frequency (c-w) oscillator signal out of the common high-voltage bus.

49. The power-input connection must be disconnected from terminal 8 of power transformer 350 and connected to terminal 1.

50. To locate a defective output filter choke in the power supply, proceed as follows:

a. Measure the voltages at test point 1.

b. Measure the d-c voltage at test point Ⓑ.

c. Turn off power supply and measure the resistance from test point Ⓑ to ground.

d. Turn on power supply and measure the a-c voltage at test point B1.

e. Measure the d-c voltage at test point B2.

f. Measure the d-c voltage at test point B3.

g. Measure the d-c voltage at test point B4.

h. Make a resistance check of output filter choke 351-2.

TROUBLE-SHOOTING SUPPLEMENT

EXPERIMENT NO. 4.

1. To simulate a shorted r-f plate-tank trimmer capacitor (204-2), turn off the receiver power and connect a fine piece of wire across the trimmer capacitor in such a manner that the wire cannot be easily seen.

2. To simulate a defective r-f-amplifier tube, replace the original tube with a specially prepared tube from which plate pin 5 has been clipped.

EXPERIMENT NO. 5

1. To simulate a defective oscillator-assembly filament-supply circuit, unsolder the filament-supply lead from the terminal strip on the oscillator assembly. The filament-supply wire is connected to the terminal nearest the front of the receiver. Carefully position the disconnected lead to make it look as though it were still connected.

2. To simulate a shorted doubler tube, remove the tube from its socket and connect a fine piece of wire between pins 1 and 2 in such a manner that the wire cannot be easily seen; then insert the tube into its socket.

EXPERIMENT NO. 6

1. To simulate a shorted diode-load filter capacitor (245-1), connect a fine piece of wire between the chassis and 4th i-f-transformer terminal which is nearest to the power-supply plug. The wire may be connected to the chassis by loosening the mounting nuts of the 4th i-f transformer, slipping the wire in between the transformer can and the chassis, and then retightening the mounting nuts. Carefully position the shorting wire so that it cannot be easily seen.

2. To simulate an open 2nd i-f plate-by-pass capacitor (230-10), unsolder the capacitor from the grounding lug. Carefully position the disconnected capacitor so that the absence of connection is not obvious.

3. To simulate an open 3rd i-f screen-grid dropping resistor (238-3), unsolder the resistor from terminal 6 of the 3rd i-f-amplifier tube socket. Carefully position the resistor to make it look as though it were still connected.

4. To simulate an open TUNING METER, disconnect one of the TUNING METER leads from its terminal. Insulate the lead with a transparent tape, such as Scotch tape, and then reconnect the lead to the TUNING METER terminal. Make certain that the lead is well insulated and that an open circuit exists.

5. To simulate a defective 2nd i-f-amplifier tube, replace the original tube with a defective one which has an open filament.

6. To simulate a shorted sensitivity-control by-pass capacitor (239-1), connect a fine piece of wire from the ungrounded terminal of the capacitor to ground. The wire may be connected to the chassis by loosening the capacitor mounting nuts, slipping the wire in between the capacitor and the chassis, and then retightening the mounting nuts. Carefully position the shorting wire so that it cannot be easily seen.

EXPERIMENT NO. 7

1. To simulate a shorted 2nd i-f a-v-c filter capacitor (230-7), connect a fine piece of wire between the right inner terminal (grid return) of the 2nd i-f transformer, 232, and the chassis. The wire may be connected to the chassis by loosening the mounting nuts of the 2nd i-f transformer, slipping the wire in between the transformer can and the chassis, and then retightening the mounting nuts. Carefully position the shorting wire so that it cannot be easily seen.

2. To simulate a shorted a-v-c bus filter capacitor (230-16), connect a fine piece of wire across the capacitor so that the wire cannot be easily seen. Capacitor 230-16 is connected to the 2nd terminal of the long terminal strip, counting from the detector-a.v.c.-1st audio amplifier tube side of the chassis.

3. To simulate an open c-w-oscillator plate dropping resistor (264), unsolder one end of the jumper lead connected between resistor 264 and resistor 268. Carefully position the disconnected lead so that the absence of connection will not be obvious. Resistor 264 is located on the terminal board at the right center of the chassis.

4. To simulate an open c-w-oscillator screen (anode) by-pass capacitor (230-20), unsolder the capacitor either from the beat-frequency (c-w) oscillator tube-socket terminal or from the terminal on the beat-frequency (c-w) oscillator grid-tank assembly, 272. Carefully position the disconnected capacitor so that the absence of connection is not obvious.

EXPERIMENT NO. 8

1. To simulate an open 1st a-f grid-coupling capacitor (230-17), unsolder one end of the jumper lead which connects capacitor 230-17 to capacitor 247. Carefully position the disconnected lead so that the absence of connection is not obvious. Both capacitors are located on the mounting strip on the right side of the chassis.

2. To simulate an open A.F. GAIN INCREASE control, unsolder the lead connected to the low end of the control. Carefully position the disconnected lead to make it look as though it were still connected.

3. To simulate a shorted 2nd a-f grid-coupling capacitor (230-18), connect a piece of very fine wire across the capacitor so that the wire cannot be easily seen. Capacitor 230-18 is mounted on the C.W. AND MANUAL-MANUAL-A.V.C. switch.

4. To simulate an open output transformer (258), disconnect the plate lead of the transformer from plate terminal 3 of the 2nd-audio-amplifier tube socket. Carefully position the disconnected lead to make it look as though it were still connected.

EXPERIMENT NO. 9

1. To simulate a defective power-supply cable, unsolder the filament-supply lead from terminal 8 of the Jones connector socket at the power-supply end of the cable.

2. To simulate a defective power-supply filter capacitor (352-2), connect a piece of very fine wire across bleeder resistor 362. Carefully position the shorting wire so that it cannot be easily seen. Also replace the original D. C. FUSE with one which is defective.

3. To simulate a shorted filter capacitor in the B-voltage distribution system of the receiver, connect a piece of very fine wire across the high-voltage filter capacitor, 230-2. Carefully position the wire so that it cannot be easily seen. Capacitor 230-2 is connected between the left inner terminal of the 1st i-f transformer and the chassis.

4. To simulate a defective rectifier tube, replace the original tube with a defective one, or insulate the filament prong of the original rectifier tube with transparent tape or some similar material.

EXPERIMENT NO. 10

Upset the receiver alignment as follows:

1. Detune the 1st and 3rd i-f transformers.

2. Detune both the grid and plate tanks of the beat-frequency (c-w) oscillator circuit.

3. Loosen the tuning dial from its shaft and shift the dial so that the line marked STOP no longer comes to the index on the dial window, then retighten the tuning dial on its shaft.

4. Detune the h-f oscillator circuit by changing the settings of the h-f-oscillator trimmer capacitor and the h-f-oscillator tank-inductance adjustment.

5. Detune the mixer circuit by changing the setting of the mixer trimmer capacitor and the spacing between the turns of the mixer grid coil.

6. Detune the r-f-amplifier circuit by changing the setting of the r-f-amplifier grid-circuit trimmer capacitor.

EXPERIMENT NO. 12

Place as many troubles into the equipment as the student is capable of finding within the allotted time for this experiment. The troubles used may be selected from this supplement.

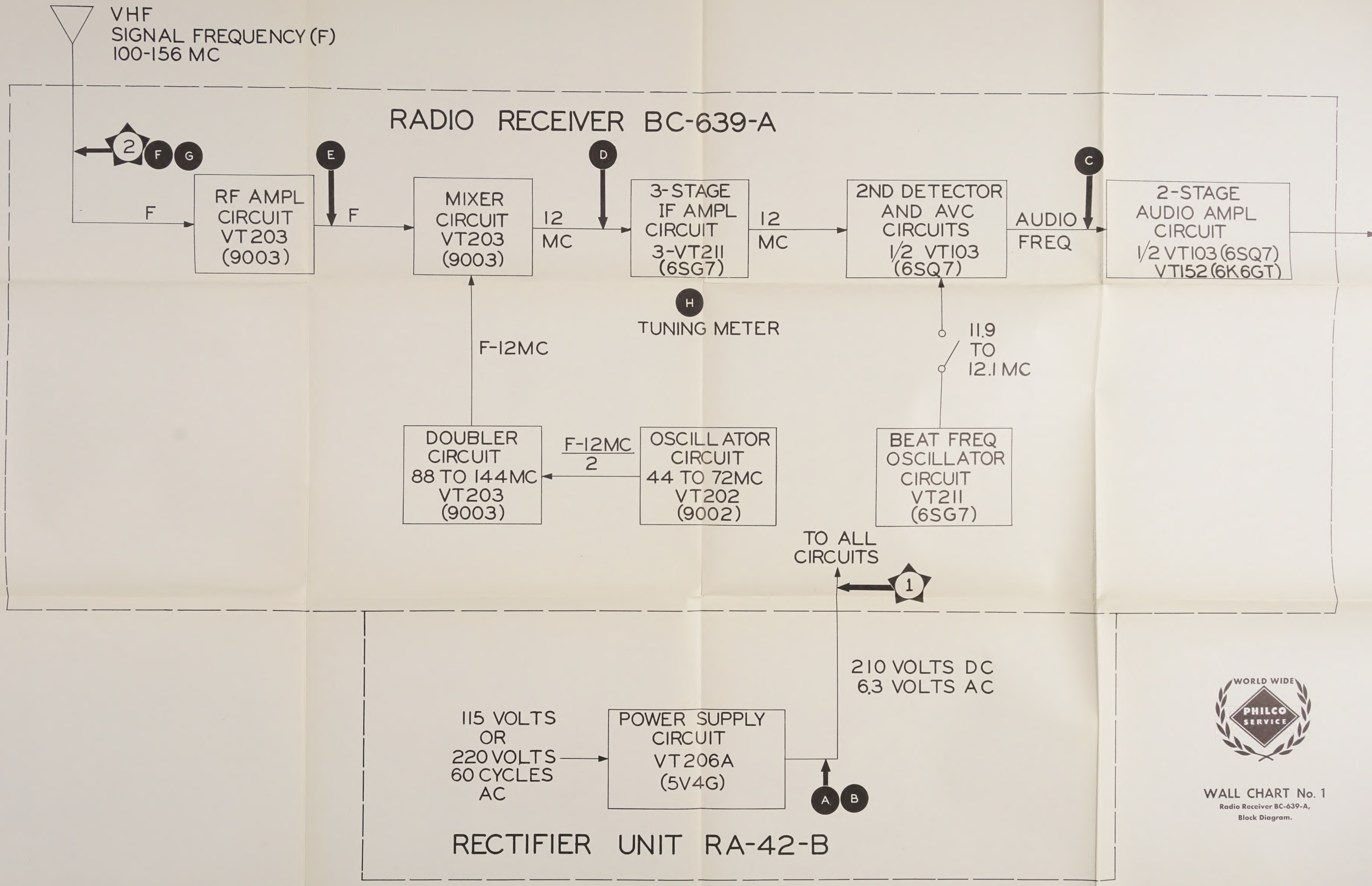
FINAL EXAMINATION

1. Decrease the sensitivity of the 3rd i-f stage by detuning the 4th i-f transformer.

2. Decrease the sensitivity of the 1st i-f-amplifier stage by unsoldering the 1st i-f a-v-c filter capacitor, 230-3, from the ground lug to which it is connected. Carefully position the disconnected capacitor to make it look as though it were still connected. Capacitor 230-3 is connected between the chassis and the right inner terminal of the 1st i-f transformer.

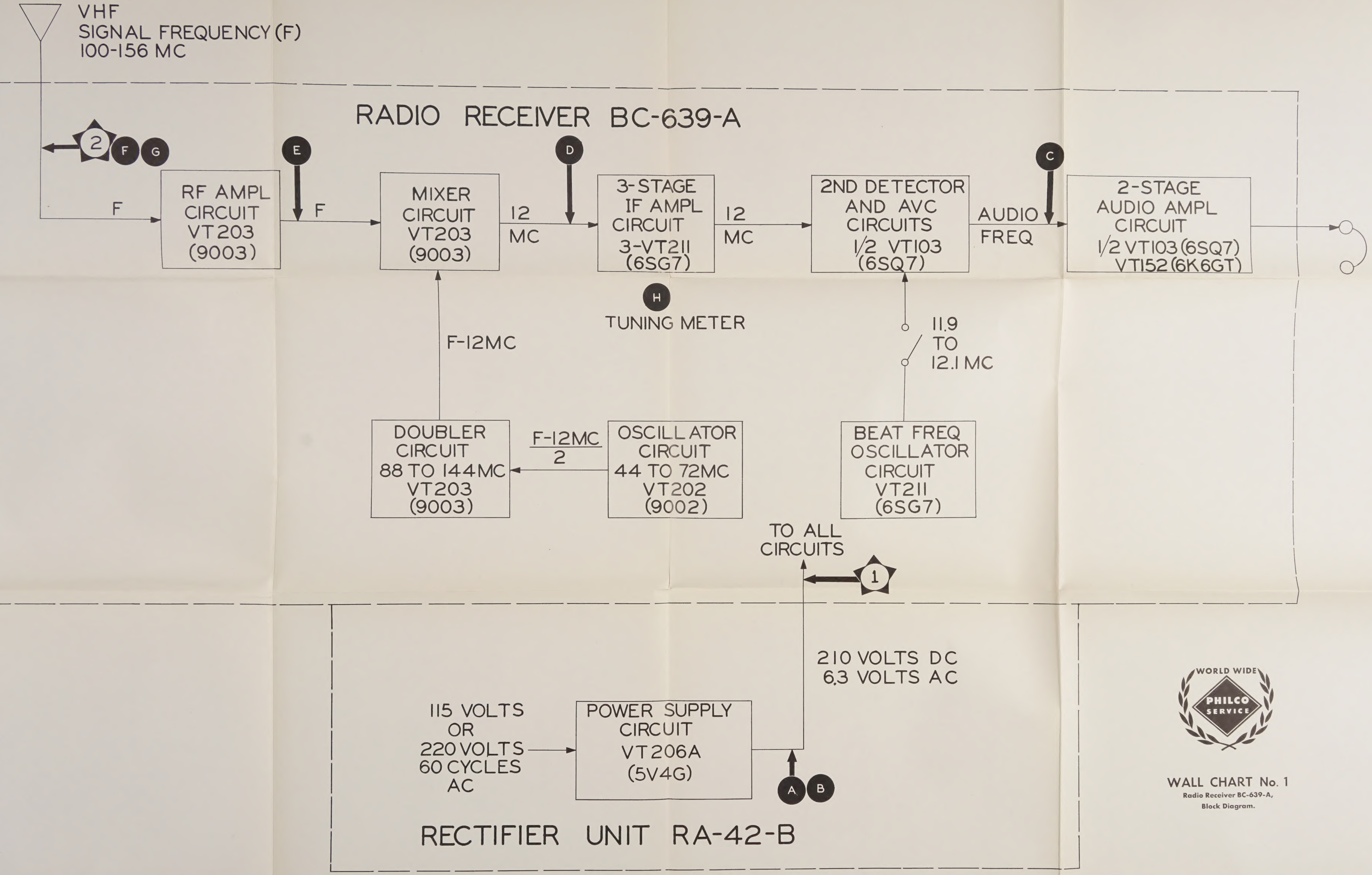
3. Decrease the sensitivity of the r-f-amplifier circuit by detuning the grid and plate tank circuits of the amplifier.

4. Simulate a defective power-supply cable by unsoldering the B-voltage-supply lead from terminal 10 of the Jones connector socket at the receiver. Make certain that the absence of connection is not obvious.


VHF
SIGNAL FREQUENCY (F)
100-156 MC
RADIO RECEIVER BC-639-A
2
F
G
E
D
C
F
RF AMPL CIRCUIT VT203 (9003)
F
MIXER CIRCUIT VT203 (9003)
12 MC
3-STAGE IF AMPL CIRCUIT 3-VT211 (6SG7)
12 MC
2ND DETECTOR AND AVC CIRCUITS 1/2 VT103 (6SQ7)
AUDIO FREQ
2-STAGE AUDIO AMPL CIRCUIT 1/2 VT103 (6SQ7) VT152 (6K6GT)
H
TUNING METER
F-12MC
11.9 TO 12.1 MC
DOUBLER CIRCUIT 88 TO 144MC VT203 (9003)
F-12MC / 2
OSCILLATOR CIRCUIT 44 TO 72MC VT202 (9002)
BEAT FREQ OSCILLATOR CIRCUIT VT211 (6SG7)
TO ALL CIRCUITS
1
210 VOLTS DC
6.3 VOLTS AC
115 VOLTS OR 220 VOLTS 60 CYCLES AC
POWER SUPPLY CIRCUIT VT206A (5V4G)
A
B
RECTIFIER UNIT RA-42-B

WORLD WIDE
PHILCO
SERVICE

WALL CHART No. 1
Radio Receiver BC-639-A,
Block Diagram.


VHF
SIGNAL FREQUENCY (F)
100-156 MC
RADIO RECEIVER BC-639-A
2
F
G
E
D
C
F
RF AMPL CIRCUIT VT203 (9003)
F
MIXER CIRCUIT VT203 (9003)
12 MC
3-STAGE IF AMPL CIRCUIT 3-VT211 (6SG7)
12 MC
2ND DETECTOR AND AVC CIRCUITS 1/2 VT103 (6SQ7)
AUDIO FREQ
2-STAGE AUDIO AMPL CIRCUIT 1/2 VT103 (6SQ7) VT152 (6K6GT)
H
TUNING METER
F-12MC
11.9 TO 12.1 MC
DOUBLER CIRCUIT 88 TO 144MC VT203 (9003)
F-12MC / 2
OSCILLATOR CIRCUIT 44 TO 72MC VT202 (9002)
BEAT FREQ OSCILLATOR CIRCUIT VT211 (6SG7)
TO ALL CIRCUITS
1
210 VOLTS DC
6.3 VOLTS AC
115 VOLTS OR 220 VOLTS 60 CYCLES AC
POWER SUPPLY CIRCUIT VT206A (5V4G)
A
B
RECTIFIER UNIT RA-42-B

WORLD WIDE
PHILCO
SERVICE

WALL CHART No. 1
Radio Receiver BC-639-A,
Block Diagram.

WORLD WIDE
PHILCO
SERVICE

WALL CHART No. 1

Radio Receiver BC-639-A,
Block Diagram.

LECTURE No. 2

GENERAL DESCRIPTION

Radio Receiver BC-639-A is a superheterodyne, which is used by both the Army and Navy in receiving v-h-f amplitude-modulated and c-w signals. It is designed to operate over a frequency range of 100 to 156 megacycles (1.92 to 3.0 meters). The operating frequency of the receiver can be varied over the entire range by means of a slow-motion drive mechanism; thus complete frequency coverage is provided without the necessity of band-switching. The receiver is capable of a power output of one watt, and is built to operate directly into a telephone-line system. A half-wave dipole antenna, located as high as possible and away from surrounding objects, such as trees, large buildings, etc. is generally used with the receiver. It is usually connected to the antenna input receptacle of the receiver by means of a coaxial transmission line.

The power requirements of the receiver are:

6.3 volts, a.c. or d. c., at 3.5 amperes.

210 volts, d.c. (180 volts minimum, 240 volts maximum) at approximately 60 milliamperes.

Since the BC-639-A has no built-in power supply the power requirements of the receiver are generally supplied by one of the following units:

Rectifier Unit	RA-42-A
Rectifier Unit	RA-42-B
Dynamotor Unit	PE-100-A

Both Rectifier Units RA-42-A and RA-42-B operate from either a 110-volt or a 220-volt, 60-cycle, a-c power source; Dynamotor Unit PE-100-A operates from a 6-volt power source.

The weight of the individual units are given below:

UNIT	WEIGHT
Radio Receiver BC-639-A	38 lbs.
Rectifier Unit RA-42-A	26 lbs.
Rectifier Unit RA-42-B	26 lbs.
Dynamotor Unit PE-100-A	24 lbs.

RADIO RECEIVER BC-639-A

There are two models of Radio Receiver BC-639-A: one model is designed for standard-rack mounting, and the other for table-top mounting. Both models are

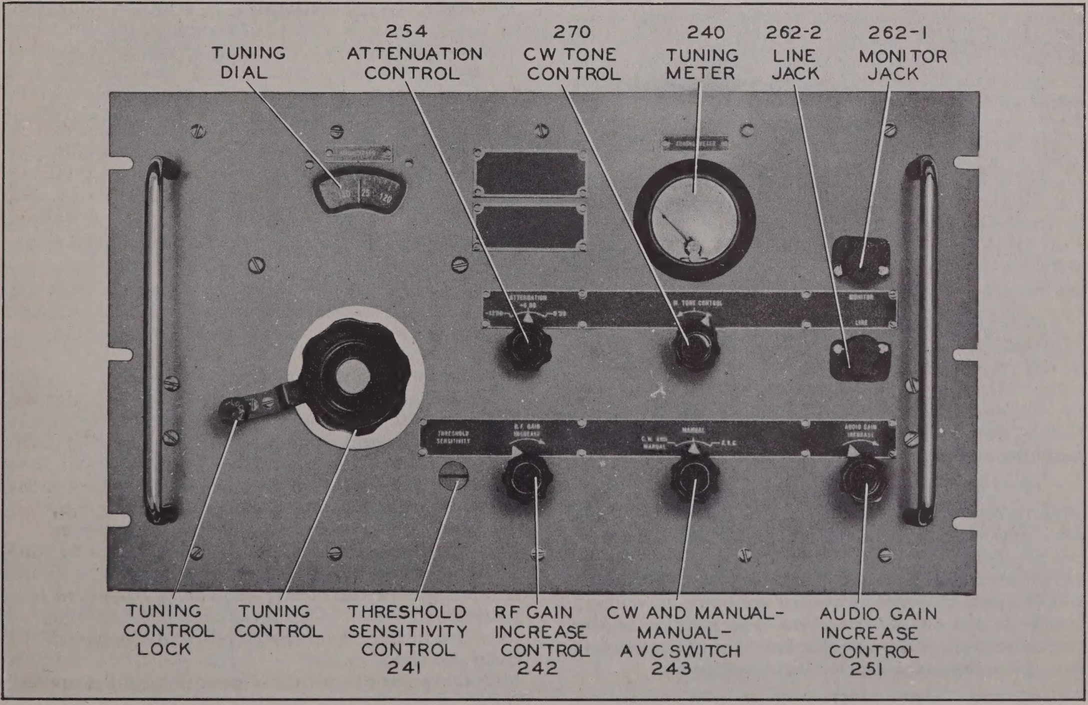

TUNING DIAL
254 ATTENUATION CONTROL
270 CW TONE CONTROL
240 TUNING METER
262-2 LINE JACK
262-1 MONITOR JACK
TUNING CONTROL LOCK
TUNING CONTROL
THRESHOLD SENSITIVITY CONTROL 241
RF GAIN INCREASE CONTROL 242
CW AND MANUAL-MANUAL-AVC SWITCH 243
AUDIO GAIN INCREASE CONTROL 251
231A

Figure 5. Radio Receiver, Front View, Showing Locations of Controls

identical except for the minor differences caused by the different cases which are used, and both have approximately the same dimensions, 19″ x 10-½″ x 13-9/16″. Each model is housed in a different type of dust-proof case, which has no ventilating louvres since the heat given off by the receiver is very small and ventilation is unnecessary. The model designed for rack-mounting is used by the U. S. Army and is housed in a standard type dust cover. The model designed for table-top mounting is used by the U. S. Navy and is generally referred to as the Table-Mounted Navy Adaptation. It is housed in a special case, Case CS-134 (see figure 8).

Handles on the front panels of both the Army and Navy models simplify the removal and replacement of the chassis, and any handling of the receiver that may be necessary. These handles also protect the panel controls from damage whenever the receiver is placed panel down.

On the front panel of the BC-639-A (see figure 5) are located the following controls, indicators, and receptacles:

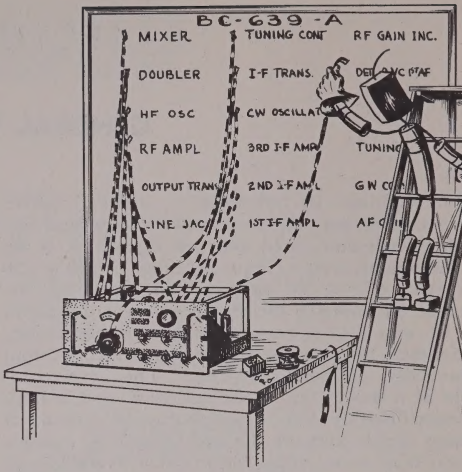
Tuning Control—This control is the large knob located on the left side of the panel. It drives the tuning dial, marked MEGACYCLES, and the five tuning capacitors which provide complete coverage of the frequency band of 100 to 156 megacycles without the necessity of band-switching. The tuning dial is calibrated directly in megacycles, and may be seen through the dial window located just above the tuning-control knob. The dial scale is indirectly lighted by a 6 to 8 -volt, .25-ampere, bayonet-base pilot lamp (Mazda #44). A tuning-control lock, which secures the setting of the tuning control, is provided on all receivers except the early models with serial numbers below 2595.

THRESHOLD SENSITIVITY Control—This control is a screwdriver adjustment located at the bottom of the panel and to the left of the row of three control knobs. It is covered by a screw cap, which must be removed before the control is accessible. This control, which is used in conjunction with the R.F. GAIN INCREASE control, sets the maximum sensitivity of the receiver to a predetermined level.

R.F. GAIN INCREASE Control—This control is the left-hand knob located at the bottom of the panel, in the row of three control knobs. It is used in manually controlling the sensitivity of the receiver up to the maximum level established by the THRESHOLD SENSITIVITY control. The arrow above the knob indicates the direction of increased sensitivity.

C.W. AND MANUAL-MANUAL-A.V.C. Switch—This three-position switch is the center knob in the row of three control knobs located at the bottom of the panel. It is used to select the method (manual or a.v.c.) of controlling the sensitivity of the receiver, and to place the beat-frequency oscillator (c-w oscillator) in, and out, of operation. The position of this switch determines whether the function of the receiver is to be communications or direction finding.

In the C.W. AND MANUAL position, the sensitivity of the receiver is manually controlled by the R.F. GAIN INCREASE control, and the automatic volume control (a.v.c.) is not in use. The beat-frequency (c-w) oscillator operates and causes an audio tone to be present in the receiver output when an unmodulated c-w signal is being received. This setting is used in taking direction-finding bearings and for locating weak signals.



In the MANUAL position, the beat-frequency (c-w) oscillator is switched off and is no longer in operation. The sensitivity of the receiver is manually controlled by the R.F. GAIN INCREASE control, the automatic volume control (avc) not being in use. This position is particularly useful in receiving modulated signals (such as modulated direction-finding signals) where manual control of the receiver sensitivity is desired.

In the A.V.C. position the beat-frequency (c-w) oscillator does not operate. The sensitivity of the receiver is automatically controlled by a-v-c action; the R. F. GAIN INCREASE control is disabled, and thus has no effect upon the receiver sensitivity. This position of the switch is especially suitable for radio-phone communication, since fading is minimized and the output of the receiver remains practically constant despite variations in carrier signal strength.

AUDIO GAIN INCREASE Control—This control is the right-hand knob located at the bottom of the panel, in the row of three control knobs. It is a variable control, which is used in conjunction with the ATTENUATION control for adjusting the audio output level (volume) of the receiver. An arrow above the control knob indicates the direction of increase.

ATTENUATION Control—This three-position switch is located at the center of the front panel and to the right of the tuning control. It is used in conjunction with the AUDIO GAIN INCREASE control to adjust the audio output level of the receiver. The three positions, marked —12 DB, —6 DB, and 0 DB, indicate the amount of attenuation introduced into the audio system by this control. In the 0 DB position, which is where the control is normally set, no attenuation is provided. In the other two positions, the audio output is attenuated by either 6 db or 12 db, depending upon the setting of this switch.

C.W. TONE CONTROL—This control is located directly below the tuning meter. It is used to vary the pitch of the audio tone that is present in the receiver output when the C.W. AND MANUAL-MANUAL-A.V.C. switch is in the C.W. AND MANUAL position and an unmodulated signal is being received. This control varies the frequency of the beat-frequency (c-w) oscillator over a small range and thus varies the pitch of the beat note (audio tone) which is produced by the beating of the incoming c-w signal with the signal from the beat-frequency (c-w) oscillator.

MONITOR Jack—This jack is the upper one of the two located on the right side of the panel. It is a headphone-type jack, and is used in monitoring incoming signals. The insertion of the headphone plug into this jack places the headphones across the output of the receiver, without disturbing the normal connection of the receiver output to the external line.

LINE Jack—This jack is the lower one of the two located on the right side of the panel. It is a line-shifting jack, which is also used in monitoring incoming signals. The insertion of the headphone plug into this jack places the headphones across the receiver output and automatically disconnects the external line.

TUNING METER—The tuning meter, located at the top of the front panel, has a number of uses. When the C.W. AND MANUAL-MANUAL-A.V.C. switch is in the A.V.C. position, the meter can be used in accurately tuning the receiver to resonance, and also in determining the relative signal strength of different carriers. The meter reading is lowest when the receiver is accurately tuned to the signal and highest when no signal is being received. The amount of deflection away from the no signal reading indicates the relative strength of the received signal, a small deflection indicating a weak signal and a large deflection indicating a strong one.

When the C.W. AND MANUAL-MANUAL-A.V.C. switch is in either the C. W. AND MANUAL or MANUAL position, the tuning meter indicates the relative sensitivity of the receiver, the smaller the meter reading the lower the receiver sensitivity and vice versa. Varying the position of the R.F. GAIN INCREASE control from minimum to maximum varies the sensitivity of the receiver and causes the meter reading to rise from zero up to a maximum value. This maximum value is preset by adjustment of the THRESHOLD SENSITIVITY control, which is generally adjusted for a sensitivity level that provides a meter reading of 5 ma. with the R.F. GAIN INCREASE control at maximum.

At the rear of the receiver (see figure 6) are located both the antenna-coupling socket (200) and a power-supply plug (263).

The antenna-coupling socket is used in connecting the antenna to the antenna input of the receiver, which

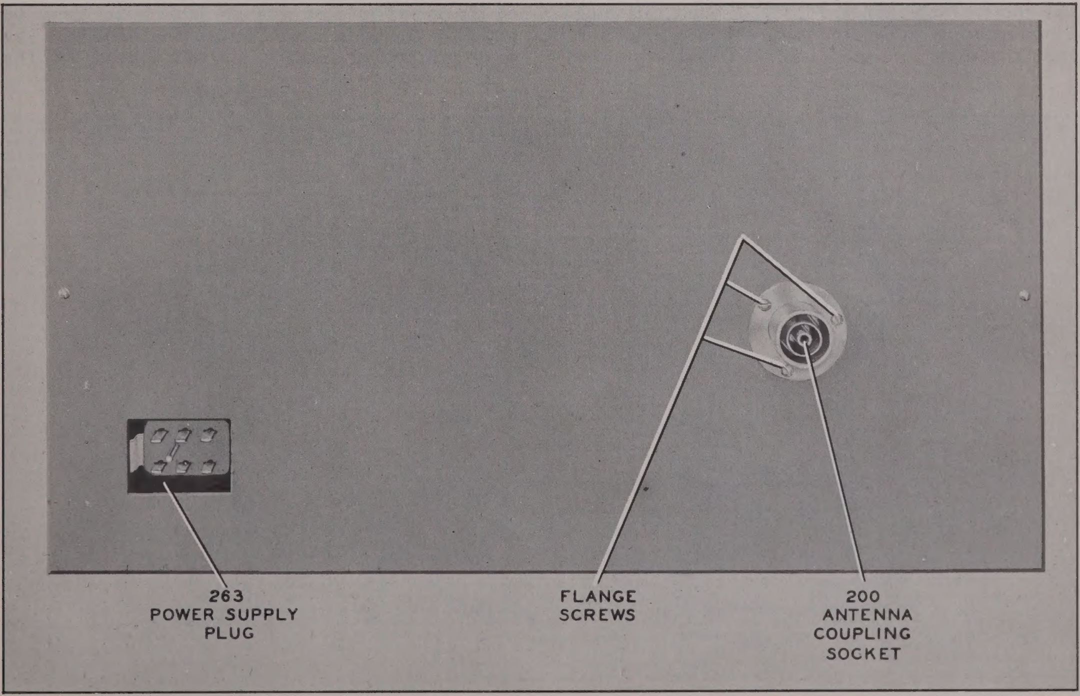


Figure 6. Radio Receiver, Rear View

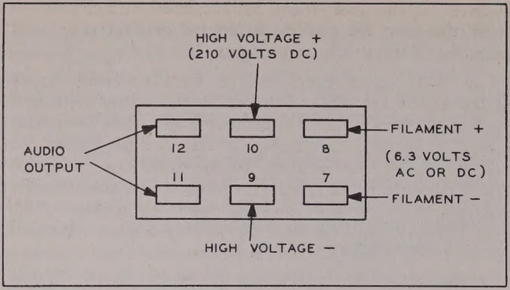


Figure 7. Power-Supply-Plug Connections

is designed to give best results when a transmission line having an impedance of 70 ohms is used. Good results may be obtained, however, with any line whose impedance is between 20 and 100 ohms. The transmission line which is generally supplied with the BC-639-A is a 70-ohm coaxial line, complete with fittings. When properly assembled and connected to the antenna, the transmission line plugs into the antenna-coupling socket (200) at the rear of the receiver, and is locked firmly in place (to the outside flange of the socket), with the lock nut that is part of the transmission-line fitting. To avoid the possibility of noise pickup, the outside shield of the transmission line is kept grounded at all times.

The power-supply plug (263) is a six-contact Jones connector plug (male). All outside connections (except for the antenna) are made through this plug. A power-supply cable, equipped with two six-contact Jones connector sockets, (female) is used to connect the output of the receiver directly into a telephone-line system, and also to supply the receiver with the power necessary for its operation. The output of the receiver is connected to contacts 11 and 12 (see figure 7) of the power-supply plug (263). Filament power is supplied to the receiver through contacts 7 and 8, and plate power through contacts 9 and 10. Both contacts 7 and 9 are connected to the chassis.

The entire receiver is mounted on a shelf-type chassis, which is fastened to the front panel, and is housed in one of the two different types of cases.

The Army model slides into a standard rack, and is held in position by six #10-32 fillister-head screws that fit through the slots in the front panel. A flat washer and lock washer are placed under the head of each screw, with the flat washer next to the panel, when fastening the BC-639-A to the mounting rack. The rack should always be placed in a position which will provide easy access to all operating controls and which will allow the receiver to be easily removed from the rack whenever necessary.

Fifteen binder-head screws hold the receiver in the dust cover. These screws provide good electrical contact between the receiver and the dust cover, thus making the shielding of the receiver complete. Five of these screws are located along the top front edge of the dust cover, and five along the bottom front edge. Five others are located on the rear surface, one on each side, out near the edge, and three around the outside flange of the antenna-coupling socket. All fifteen screws must be removed before the receiver can be taken from the dust cover.

The hole in the dust cover for the antenna-coupling socket is not large enough to permit the outside flange of the socket to pass through. This flange must be removed, therefore, before attempting to remove the receiver from, or place it into the dust cover. The

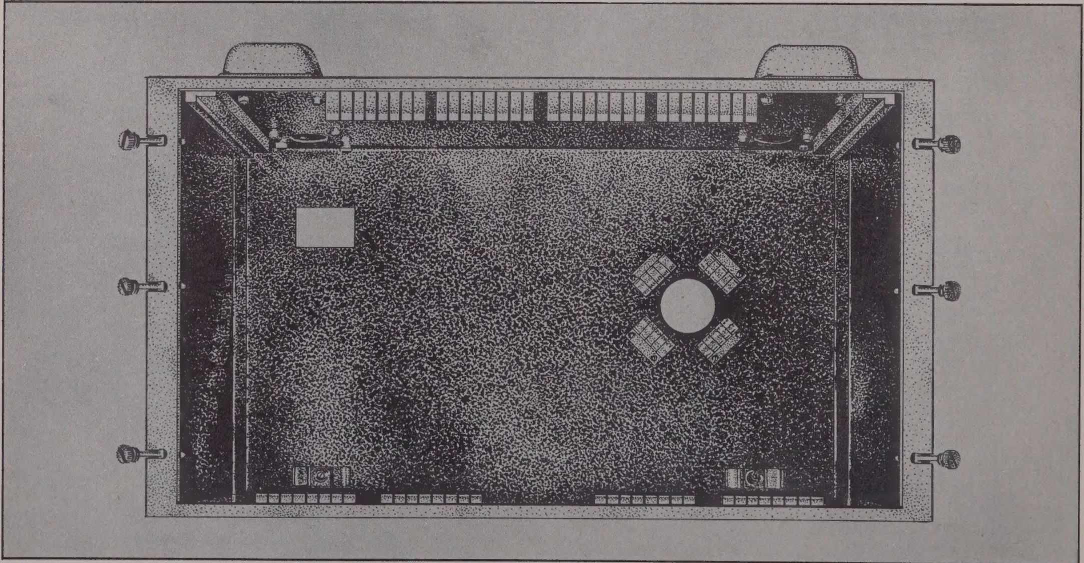


Figure 8. Case CS-134, Front View

three screws around the outside flange of the antenna-coupling socket (figure 6) fasten the flange to the dust cover and to the inside flange of the antenna-coupling socket.

The Navy model is usually table-mounted. Case CS-134 (see figure 8) is supported on four Lord shock mounts, and is fastened to the table by means of mounting screws that pass through a washer and sleeve on the shock mount. The table should always be placed in a position which will allow easy access to all operating controls and which also will permit the receiver to be easily removed from the case.

Six knurled thumbscrews, which fit into the slots on the front panel of the receiver (three on each side), hold the receiver in the case. These screws are not removable and are part of Case CS-134. They are fastened in slots to permit movement, and are held to the case by C washers.

Twelve sets of contact springs, located on the inside of the case, provide good electrical contact between the case and the receiver, thus making the shielding of the receiver complete. Four sets of these contacts are located along the top front of the case, four sets along the bottom front, and four sets around the antenna-coupling-socket hole at the rear of the case.

The antenna-coupling-socket hole is large enough to permit the antenna-coupling socket with its outside flange to pass through; unlike the Army model, therefore, it is unnecessary to remove the flange when removing the receiver from, or placing it into the case. However, the six knurled thumbscrews which hold the receiver in the case must be loosened sufficiently to allow them to be pushed sideways so that they will clear the slots in the front panel.

The dust cover used in the rack-mounted Army model and Case CS-134 used in the table-mounted, Navy Adaptation, are interchangeable. For instance, Case CS-134 may be replaced with a dust cover for rack-mounting the receiver in the following manner. After removing the receiver from Case CS-134, the outside flange of the antenna-coupling socket is removed by removing the three binder-head screws which hold it in place. The receiver is then placed into the dust cover, and the outside flange of the antenna-coupling socket is fastened in place (to the outside of the dust cover and to the inside flange) with the three screws which were previously removed. Twelve additional binder-head screws are necessary to fasten the dust cover to the receiver.

When the receiver is removed from the dust cover or case, components located beneath and on top of the receiver chassis are readily accessible. On the top left side of the chassis, directly behind the tuning control, there are two assemblies, the r-f assembly (275) and the oscillator assembly (274). See figure 9. These assemblies are used together in selecting and amplifying incoming signals. The r-f assembly utilizes two type VT-203 (9003) tubes; the one nearest the front panel is an r-f amplifier and the other is a mixer. The oscillator assembly also uses two tubes; the VT-202 (9002), nearest the front panel, is an h-f oscillator and the VT-203 (9003) is a frequency doubler. Each

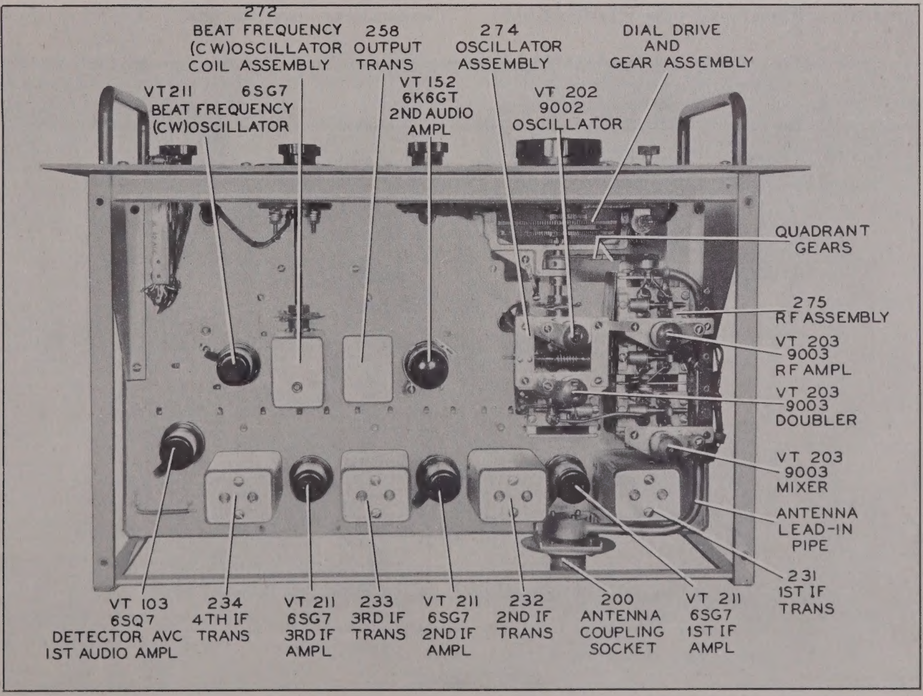

272 BEAT FREQUENCY (CW)OSCILLATOR COIL ASSEMBLY
258 OUTPUT TRANS
274 OSCILLATOR ASSEMBLY
DIAL DRIVE AND GEAR ASSEMBLY
VT211 6SG7 BEAT FREQUENCY (CW)OSCILLATOR
VT 152 6K6GT 2ND AUDIO AMPL
VT 202 9002 OSCILLATOR
QUADRANT GEARS
275 RF ASSEMBLY
VT 203 9003 RF AMPL
VT 203 9003 DOUBLER
VT 203 9003 MIXER
ANTENNA LEAD-IN PIPE
231 1ST IF TRANS
VT 103 6SQ7 DETECTOR AVC 1ST AUDIO AMPL
234 4TH IF TRANS
VT 211 6SG7 3RD IF AMPL
233 3RD IF TRANS
VT 211 6SG7 2ND IF AMPL
232 2ND IF TRANS
200 ANTENNA COUPLING SOCKET
VT 211 6SG7 1ST IF AMPL
164A

Figure 9. Radio Receiver, Top View, Showing Locations of Tubes and Components

assembly is mounted to the main chassis with two nuts and one screw. Each assembly is complete in itself, since it requires only the application of power to make it work. Both power and output connections to the r-f assembly are made at the terminal strip on the left side of the r-f assembly. Connections to the oscillator assembly are made at the terminal strip on the right side of the oscillator assembly. The three-section tuning condenser on the r-f assembly is mechanically coupled to the two section tuning condenser on the oscillator assembly, by means of two quadrant gears (see figure 9). These gears are mechanically coupled to the tuning control (dial drive and gear assembly), which is used to vary the tuning condensers of both assemblies simultaneously. The gear arrangement in the tuning-control assembly provides the necessary vernier action for accurately tuning the assemblies, and the MEGACYCLES dial provides an accurate indication of the frequency to which the assemblies are tuned.

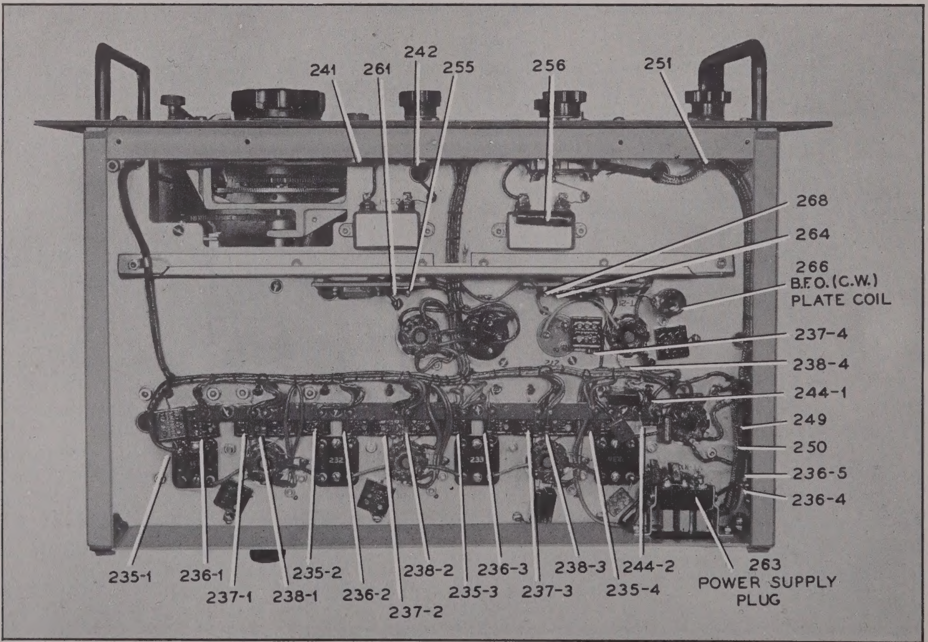
At the rear of the chassis, extending in a row along the entire width of the chassis, are four 12-megacycle intermediate-frequency (i-f) transformers and three VT-211 (6SG7) i-f amplifier tubes. These components are used in amplifying the signal and providing the receiver with the desired selectivity. The 1st i-f transformer (231), is located at the extreme left side of the chassis. To the right of this transformer, and in the order given, are the following: 1st i-f amplifier tube, 2nd i-f transformer (232), 2nd i-f amplifier tube, 3rd i-f transformer (233), 3rd i-f amplifier tube, and 4th i-f transformer (234). To the right and slightly in front of the 4th i-f transformer (234) is the 2nd-detector-1st-audio-amplifier-a-v-c tube VT-103 (6SQ7). It is used to demodulate the incoming signal, to amplify it, and also to produce an a-v-c voltage for controlling the sensitivity of the receiver. In the center of the chassis and directly in front of the 2nd i-f amplifier tube is the 2nd audio amplifier or audio-output tube VT-152 (6K6). This tube is used in conjunction with the output transformer (258), which is located to the right of the audio-output tube, to provide the necessary audio power for operating sound-reproducing devices, such as headphones etc. To the right of the audio-output transformer is the beat-frequency (c-w) oscillator coil assembly (272) and the beat-frequency (c-w) oscillator tube VT-211 (6SG7). These components are used in producing a beat note (audio tone) when receiving continuous wave (c-w) signals.

Mounted underneath the chassis (see figures 10 and 11) are the power supply plug (263), the beat-frequency (c-w) oscillator coil (266), and many other circuit components whose purposes are discussed later.

POWER SUPPLY

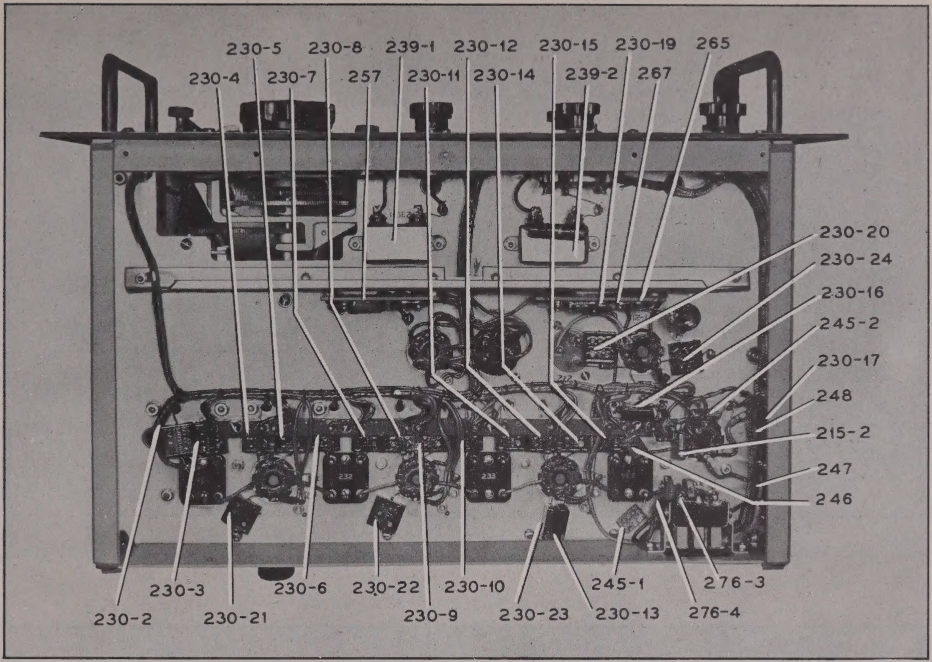
Power for operating the BC-639-A receiver may be supplied by any one of the three different power supplies mentioned previously—Rectifier Unit RA-42-A, Rectifier Unit RA-42-B, or Dynamotor Unit PE-100-A.

The dimensions of both Rectifier Units RA-42-A and RA-42-B are the same, 19″ x 6-31/32″ x 8-23/32″. Both rectifier units may be operated from either a 110-volt power source, at voltages ranging from 90 to 140 volts, or from a 220-volt power source, at voltages ranging from 200 to 250 volts, by simply changing connections inside the unit.



226A

Figure 10. Radio Receiver, Bottom View, Showing Locations of Components



226B

Figure 11. Radio Receiver, Bottom View, Showing Locations of Components

When either Rectifier Unit RA-42-A or RA-42-B is used in an installation for supplying the receiver with power, it is connected directly to the receiver by means of a cable equipped with two Jones connector sockets (female). Whenever the rectifier unit is switched on, power is also applied to the receiver since the receiver has no power switch of its own.

The dimensions of Dynamotor Unit PE-100-A are 19″ x 10-15/16″ x 8-11/16″. This unit operates from a 6-volt d-c power source, and is used in conjunction with Switch Panel PN-6-A. When Dynamotor Unit PE-100-A is used in an installation for supplying the receiver with power, it is connected directly to the receiver by means of a cable equipped with a Jones connector socket (female). A single-pole, single-throw switch, located on Switch Panel PN-6-A, is used to switch both the dynamotor unit and the filament circuit to the receiver on and off.

In an installation where both Rectifier Unit RA-42-A (or Rectifier Unit RA-42-B) and Dynamotor Unit PE-100-A are used, a switch panel provides the means for quickly connecting either power supply to the receiver.

Since both Rectifier Units RA-42-A and RA-42-B are similar, and since Dynamotor Unit PE-100-A is a conventional type dynamotor, only Rectifier Unit RA-42-B will be discussed.

RECTIFIER UNIT RA-42-B

Rectifier Unit RA-42-B is housed in a standard type of dust cover, which is held in place by two binder-head screws located at the rear of the unit. The rectifier unit is designed for standard rack mounting, and is held in position on the rack by four #10-32 fillister-head screws, which fit through the slots in the front panel. Handles on the front panel simplify the removal and replacement of the chassis and any other handling of the unit that may be necessary. These handles also protect the panel controls from damage whenever the unit is placed panel down.

On the front panel of the Rectifier Unit RA-42-B (see figure 12) are located the following controls, fuses, etc.:

SUPPLY VOLTAGE control—This control, which is located at the bottom center of the panel, is a compensating control for the power-source voltage. For different values of power-source voltage, this control is used to adjust the input circuit of the rectifier unit so that the required output voltage is obtained.

A. C. SUPPLY FUSES—These two fuses, which are located to the left of the SUPPLY VOLTAGE control, protect the rectifier unit from damage caused by abnormal loads or by improper power-source voltages.

POWER ON switch—This switch, which is located to the right of the SUPPLY VOLTAGE control, is used to turn the rectifier unit on and off.

D.C. FUSE—This fuse, located to the right of the POWER ON switch, protects the high-voltage rectifier circuit from damage due to overloads, etc.

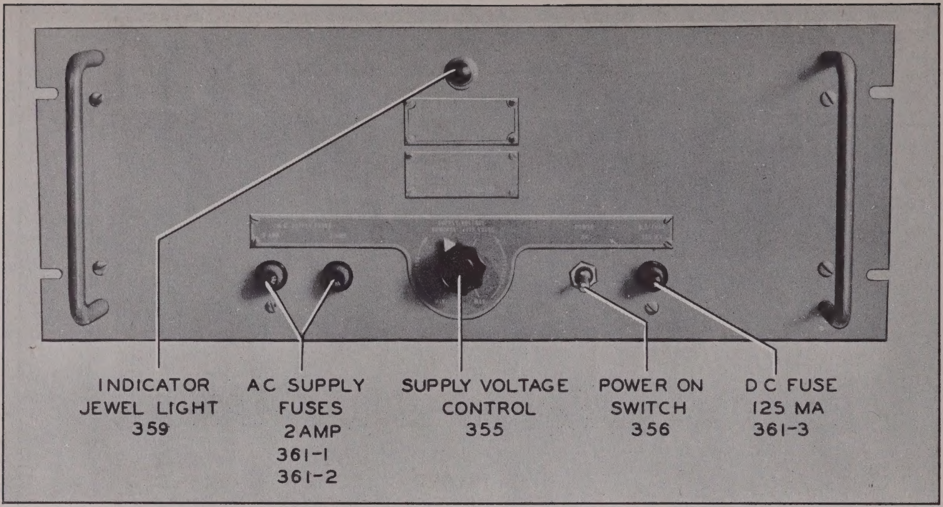

INDICATOR JEWEL LIGHT 359
AC SUPPLY FUSES 2AMP 361-1 361-2
SUPPLY VOLTAGE CONTROL 355
POWER ON SWITCH 356
D C FUSE 125 MA 361-3
228A

Figure 12. Rectifier Unit RA-42-B, Front View, Showing Locations of Controls

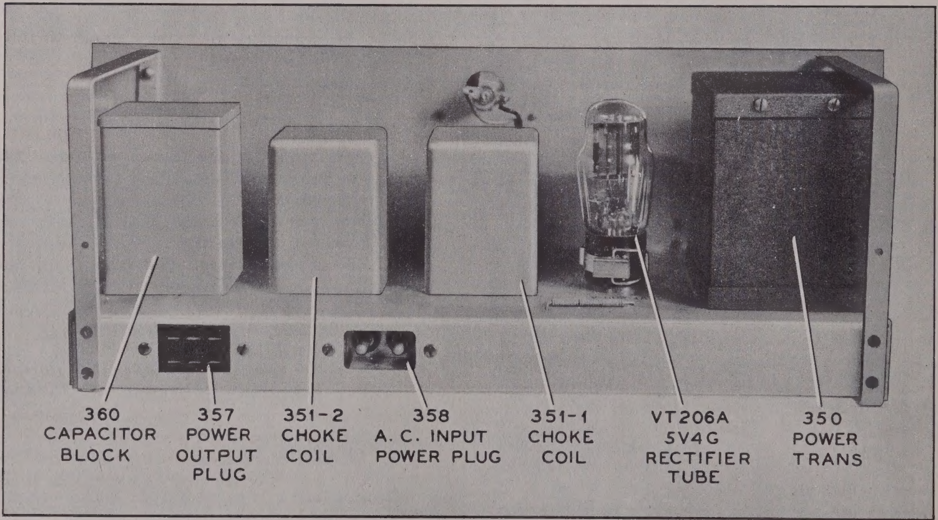

360 CAPACITOR BLOCK
357 POWER OUTPUT PLUG
351-2 CHOKE COIL
358 A. C. INPUT POWER PLUG
351-1 CHOKE COIL
VT206A 5V4G RECTIFIER TUBE
350 POWER TRANS
227

Figure 13. Rectifier Unit, Rear View, Showing Locations of Major Components

Indicator jewel light—This light, which is located at the top center of the panel, indicates whether the rectifier unit is turned on or off.

At the rear of the rectifier unit (see figure 13) are two recessed plugs. The one nearest the left edge is a six-contact Jones connector plug (357) and the other is a two-contact connector plug (358). The six-contact plug provides the output voltages of the rectifier unit. Contacts 7 and 8 on the plug are connected to supply 6.3 volts, a.c., for filament lighting purposes, and contacts 9 and 10 are connected to supply 210 volts, d.c., for B voltage purposes. Both contacts 7 and 9 are connected to the chassis and contacts 11 and 12 are blank. A power-supply cable, which is equipped with two 6-contact Jones connector sockets (female), is used to connect the rectifier unit to the receiver.

The 2-contact plug is the a-c input power plug. A cord, which is equipped with a special receptacle that fits onto this plug, is used to supply the rectifier unit with the a.c. power required for its operation.

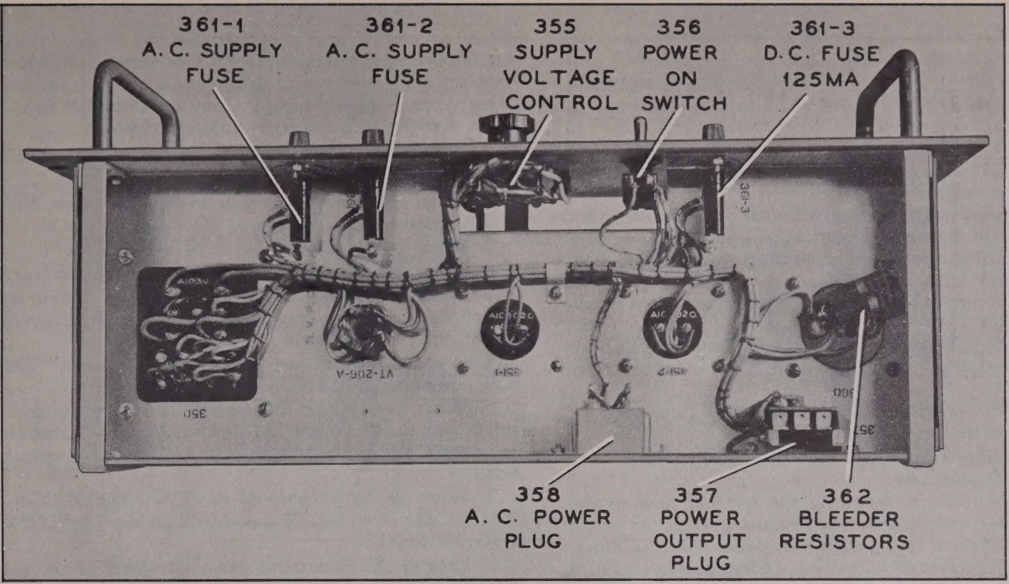


Figure 14. Rectifier Unit, Bottom View

When the dust cover is removed from the rectifier unit, the components located on top of, and beneath the rectifier-unit chassis are readily accessible. On the top right side of the chassis (see figure 13) is the power transformer (350), which supplies the a-c filament voltage for the receiver and also the a-c operating voltages for the rectifier unit. Next to the power transformer is the rectifier tube VT-206-A (5V4G), which converts the a-c voltage, obtained from the power transformer, into d-c voltage. To the left of the rectifier tube are the high-voltage filter components, choke coils 351-1 and 351-2, and capacitor block 360. These components are used to filter the output of the rectifier tube. Capacitor block 360 contains two 6-uf. capacitors. Mounted underneath the chassis (see figure 14) are the power-output plug 357, the a-c power plug 358, and two bleeder resistors 362. The two resistors discharge the filter capacitors when the unit is switched off under no-load conditions, thus eliminating the possibility of shock.

LESSON PLAN No. 2

TIME ALLOTTED: 1½ HR.

SUBJECT

General description.

OBJECTIVE

To describe Radio Receiver BC-639-A and its power-supply unit.

INTRODUCTION

Radio Receiver BC-639-A is a stable v-h-f radio communications receiver which provides complete coverage of its operating frequency band of 100 to 156 megacycles by means of a single master control.

SUBJECT MATERIAL

1. Characteristics of the over-all equipment.
   - a. Operating frequency and method of tuning.
   - b. Power output.
   - c. Antenna used.
   - d. Power requirements.
   - e. Power-supply units.
   - f. Weight of individual units.
2. Radio Receiver BC-639-A.
   - a. Models of BC-639-A.
   - b. Dimensions.
   - c. Cases used.
   - d. Location and purpose of panel controls, jacks, etc.
   - e. Location and purpose of antenna-coupling socket and power-supply plug.
   - f. Method of rack-mounting the Army model.
   - g. Manner of fastening the receiver in the dust cover.
   - h. Disadvantages of the small antenna-coupling-socket hole in the dust cover.
   - i. Method of table-mounting the Navy model.
   - j. Manner of fastening the receiver in Case CS-134.
   - k. Location and purpose of the contact springs in Case CS-134.
   - l. Advantages of the large antenna-coupling-socket hole in Case CS-134.
   - m. Interchanging Case CS-134 for a standard dust cover.
   - n. Location and purpose of components located on top of chassis.

   Use Radio Receiver BC-639-A as shown in figure 9 to illustrate.

o. Location and purpose of components mounted underneath chassis.
Use Radio Receiver BC-639-A as shown in figures 10 and 11 to illustrate.

3. The power supply.
   a. Types used.
   b. Dimensions and operating power of the rectifier units.
   c. Supplying the receiver with power from either one of the rectifier units.
   d. Dimensions and operating power of Dynamotor Unit PE-100-A.
   e. Supplying the receiver with power from Dynamotor Unit PE-100-A.
   f. Supplying the receiver with power from both Dynamotor Unit PE-100-A and either rectifier unit.
   g. Reason for limiting discussion of power-supply units to Rectifier Unit RA-42-B.
4. Rectifier Unit RA-42-B.
   a. Type of case.
   b. Manner of fastening the rectifier unit in the dust cover, and to the mounting rack.
   c. Location and purpose of panel controls, fuses, etc. Use Rectifier Unit RA-42-B as shown in figure 12 to illustrate.
   d. Location and purpose of the plugs at the rear of the unit. Use Rectifier Unit RA-42-B as shown in figure 13 to illustrate.
   e. Location and purpose of major components mounted on top of rectifier-unit chassis. Use rectifier unit as shown in figure 13 to illustrate.
   f. Location and purpose of major components mounted underneath chassis of the rectifier unit. Use rectifier unit as shown in figure 14 to illustrate.

CONCLUSIONS

From the preceding discussion, it is seen that there are two models of Radio Receiver BC-639-A, a table-mounted model which is used by the Navy and a rack-mounted model which is used by the Army. Both models are identical except for a few minor differences that are due to the use of different cases. Both use the same types of power supplies, and are designed to operate directly into a telephone-line system.

ORAL QUIZ

1. What types of signals may be received by the BC-639-A receiver?

2. What is the power output of the receiver?

3. What are the power requirements of the receiver?

4. What is the official nomenclature of the units which are used to supply the receiver with power? What are their operating voltages?

5. What is the purpose of the tuning control? The C.W. MANUAL-MANUAL-A.V.C. switch?

6. What determines the sensitivity of the receiver when the C. W. MANUAL-MANUAL-A.V.C. switch is in the C.W. MANUAL position? Is the b.f.o. operating?

7. What is the purpose of the C.W. TONE CONTROL? The MONITOR and LINE jacks? The TUNING METER?

8. How is the maximum sensitivity level of the receiver set?

9. Why is a 70-ohm transmission line used to connect the antenna to the receiver?

10. How is the Army model mounted? The Navy model?

11. What are the differences between the Army and Navy models?

12. What is the procedure for replacing Case CS-134 with the Army dust cover?

13. Where, on the receiver chassis, are the r-f and oscillator assemblies located? What is the purpose of each assembly?

14. How many cables are used in supplying the receiver with power?

15. What is the purpose of the SUPPLY VOLTAGE control on Rectifier Unit RA-42-B?

EXPERIMENT No. 1

TIME ALLOTTED: 2 HR.

SUBJECT

Identification of components.

OBJECTIVE

To familiarize the trainee with the physical location of major components, controls, etc. of the radio receiver and power-supply units.

EQUIPMENT REQUIRED

1 Radio Receiver BC-639-A.
1 Rectifier Unit RA-42-B.

INSTRUCTIONS

Make certain that the power supply (Rectifier Unit RA-42-B) is not connected to the power source.

PROCEDURE

1. In the sketches of the receiver front panel (figure A) and the power supply front panel (figure B) are shown controls, switches, etc. Using these sketches, give the reference symbol and name of each of the items listed in the following chart:

ITEM NO.	REFERENCE SYMBOL	NAME
1		
2		
3		
4		

ITEM NO.	REFERENCE SYMBOL	NAME
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		

ITEM NO.	REFERENCE SYMBOL	NAME
16		
17		
18		

2. Remove the receiver from the dust cover. Proceed in the following manner.

a. Remove the 15 screws which hold the receiver in the dust cover. Five of these screws are located along the top front edge, and five along the bottom front edge of the dust cover. Five others are located on the rear surface, one on each side near the edge, and three around the outside flange of the antenna coupling socket.

b. Lift the rectifier unit from dust cover.

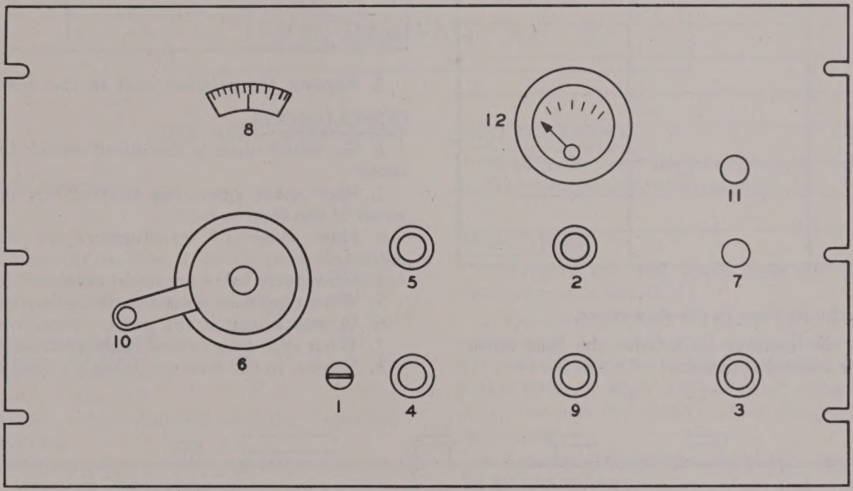


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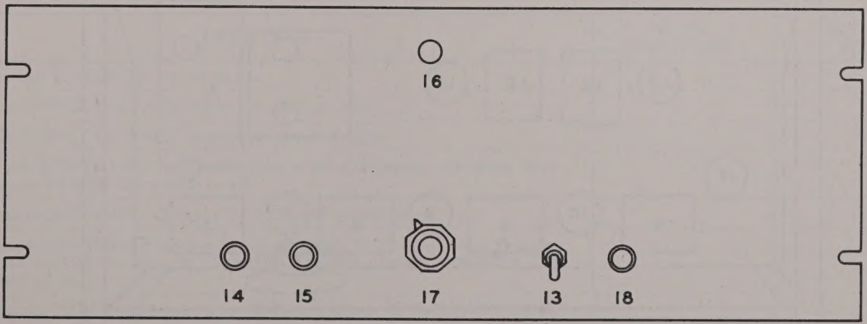
Figure A



TP9-1328

Figure B

3. In the sketch (figure C) are shown the locations of major components, assemblies etc., which are mounted on the receiver chassis. Using this sketch, give the reference symbol and name of each of the items listed in the following chart:

ITEM NO.	REFERENCE SYMBOL	NAME
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		

4. Replace the receiver in the dust cover.

5. Remove the rectifier unit from the dust cover. Proceed in the following manner:

a. Remove the two screws at the rear of the power-supply unit.

b. Lift the rectifier unit from the dust cover.

6. In the sketch (figure D) are shown the locations of the major components which are mounted on the rectifier-unit chassis. Using this sketch, give the reference symbol and name of each of the items listed in the following chart:

ITEM NO.	REFERENCE SYMBOL	NAME
1		
2		
3		
4		
5		
6		
7		
8		

7. Replace the rectifier unit in the dust cover.

CONCLUSIONS

1. On which unit is the on-off switch located? The fuses?
2. How many operating controls are on the front panel of the receiver?
3. How many i-f transformers are there in the receiver?
4. How many tubes are in the receiver?
5. What type tube is used as the 2nd-audio amplifier?
6. In which unit is the power transformer located?
7. What type tube is used as the rectifier?
8. Where, in the receiver, is the r-f assembly located?

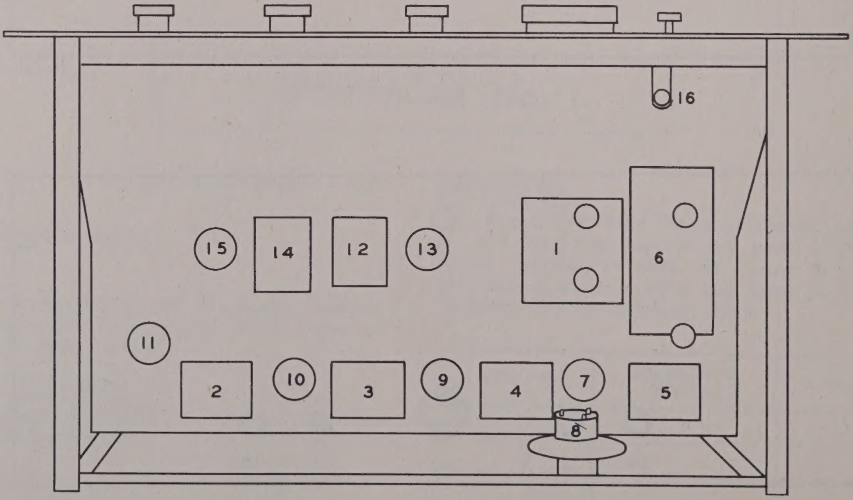


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Figure C

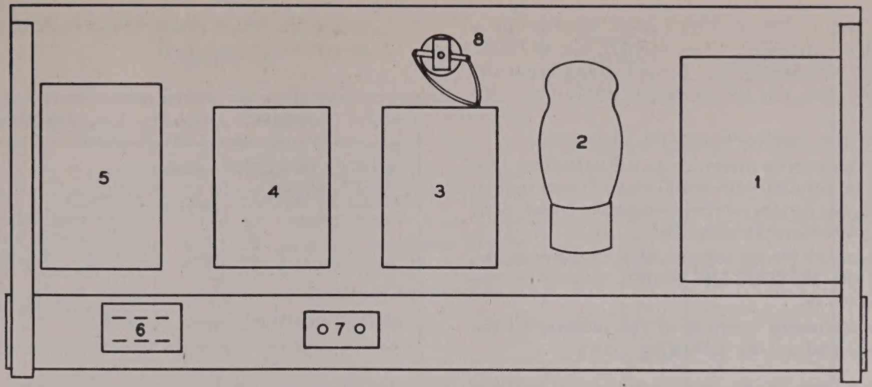


Figure D

EXPERIMENT No. 2

TIME ALLOTTED: 2 HR.

SUBJECT

Operation of equipment.

OBJECTIVE

To familiarize the trainee with the purpose of the panel controls, adjustments, etc., and the normal indications of a correctly operating equipment.

EQUIPMENT REQUIRED

1 Radio Receiver BC-639-A.
1 Rectifier Unit RA-42-B.
1 Power-supply cable equipped with two Jones connector sockets.
1 D-c voltmeter.
1 Output meter or a-c voltmeter.
1 Headphone set.
1 600-ohm, 2-watt carbon resistor, or equivalent.
1 Frequency Meter BC-638-A, with a 7222.222-kc. crystal.

INSTRUCTIONS

Make certain that the power supply is not connected to the power source, or to the receiver.

PROCEDURE

1. Remove the dust cover from the power supply (Rectifier Unit RA-42-B).

2. Connect the positive lead of a d-c voltmeter (500-volt range) to terminal 10 of the power output plug, 357, and the negative lead to the chassis.

CAUTION: A high d-c potential exists between terminal 10 and the chassis when the power supply is turned on.

3. Connect the power supply to a power source of the proper voltage.

4. Perform each of the operations given in the following chart, and list both the meter indication and the approximate intensity of the jewel indicator light for each operation.

OPERATION	METER INDICATION	JEWEL LIGHT INTENSITY
1. Operate POWER ON switch to on.		
2. Turn SUPPLY VOLTAGE control to extreme left.		
3. Turn SUPPLY VOLTAGE control to extreme right.		
4. Adjust SUPPLY VOLTAGE control for a 220-volt meter indication, then operate POWER ON switch to off.		
5. Remove D. C. FUSE. Operate POWER ON switch to on.		
6. Operate POWER ON switch to off. Replace D. C. FUSE, and remove either one of the two A. C. SUPPLY FUSES. Operate POWER ON switch to on.		
7. Operate POWER ON switch to off, then replace A. C. SUPPLY FUSE. Connect power supply to the receiver, using the cable equipped with the two Jones connector sockets. Operate POWER ON switch to on.		

5. Adjust the SUPPLY VOLTAGE control for a 210-volt meter indication. Then operate the POWER ON switch to off. Disconnect the d-c meter from the power supply, and the power-supply cable from the receiver.

6. Remove the receiver from the dust cover.

7. Connect an output meter, or an a-c voltmeter (30-volt range), in parallel with a 600-ohm, 2-watt carbon resistor, or its equivalent, across terminals 11 and 12 of the receiver power-supply plug, 263.

8. Reconnect the power-supply cable to the receiver, and operate the POWER ON switch, located on the power supply, to on.

9. Set the operating controls of the receiver to the positions indicated in the following chart.

CONTROL	POSITION
ATTENUATION switch	O DB
C. W. TONE CONTROL	Center line
R. F. GAIN INCREASE control	maximum clockwise
C. W. AND MANUAL-MANUAL-A.V.C. switch	MANUAL
AUDIO GAIN INCREASE control	maximum clockwise

10. Insert the headphones plug into the MONITOR jack on the front panel of the receiver.

11. Prepare the frequency meter (Frequency Meter BC-638-A) for use in the following manner:

a. Insert the 7222.222-kc. crystal into crystal receptacle 3.

b. Connect the 12-½-inch rod antenna, obtained from within the frequency meter, to the antenna receptacle on the front panel.

c. Connect the frequency meter to a power source of the proper voltage.

d. Set the operating controls on the front panel of the frequency meter to the positions indicated in the following chart.

CONTROL	POSITION
CRYSTAL SELECTOR switch	3
ON-OFF switch	ON
STAND BY-OPERATE switch	OPERATE
Tuning control	To position where MEGACYCLES dial is at approximately 130 megacycles, and the smallest shadow angle is obtained on the magic-eye-indicator tube
OUTPUT CONTROL switch	MAX

12. Place the frequency meter (BC-638-A) within a few feet of the receiver. Adjust the tuning control, on the front panel of the receiver, to the position where the MEGACYCLES dial is at approximately 130 mc., and the output-meter indication is maximum. NOTE: Usually it is unnecessary to use an antenna on the receiver in order to obtain a satisfactory output indication; however, if the signal from the frequency meter cannot be received, a rod antenna similar to the rod antenna used on the frequency meter should be used on the receiver.

13. Adjust the position of the frequency meter in relation to the receiver and/or the OUTPUT CONTROL on the front panel of the frequency meter for a receiver output-meter indication of approximately half scale. Then set the STAND BY-OPERATE switch on the front panel of the frequency meter to STAND BY.

14. Perform each of the operations given in the following chart, and record the panel-meter readings, the output-meter readings, and the type and intensity of the sound produced in the headphones.

STEP	OPERATION	PANEL METER INDICATION	OUTPUT METER INDICATION	TYPE AND INTENSITY OF SOUND
1	Set THRESHOLD SENSITIVITY control to minimum (counterclockwise).			
2	Slowly adjust THRESHOLD SENSITIVITY control to maximum (clockwise).			
3	Slowly rotate R. F. GAIN INCREASE control from maximum (clockwise) to minimum (counterclockwise).			
4	Reset R. F. GAIN INCREASE control to maximum. Set C. W. AND MANUAL-MANUAL-A.V.C. switch to C. W. AND MANUAL and repeat operation 1.			
5	Repeat operation 2.			
6	Repeat operation 3.			
7	Reset R. F. GAIN INCREASE control to maximum. Set C. W. AND MANUAL-MANUAL-A.V.C. switch to A. V. C. position, and repeat operation 1.			
8	Repeat operation 2.			
9	Repeat operation 3.			
10	Reset R. F. GAIN INCREASE control to maximum. Set C. W. AND MANUAL-MANUAL-A. V. C. switch to MANUAL. Adjust THRESHOLD SENSITIVITY control to position where panel meter indicates 5 ma. (This is the standard sensitivity setting.)			

STEP	OPERATION	PANEL METER INDICATION	OUTPUT METER INDICATION	TYPE AND INTENSITY OF SOUND
11	On front panel of frequency meter, set STANDBY-OPERATE switch to OPERATE, and repeat operation 3.			
12	Reset R. F. GAIN INCREASE control to maximum. Slowly rotate AUDIO GAIN INCREASE control from maximum (clockwise) to minimum (counterclockwise).			
13	Reset AUDIO GAIN INCREASE control to maximum. Slowly rotate C. W. TONE CONTROL from minimum to maximum.			
14	Reset C. W. TONE CONTROL to center line. Set ATTENUATION switch to —6 DB.			
15	Set ATTENUATION switch to —12 DB.			
16	Reset ATTENUATION switch to 0 DB. Slowly rotate tuning control so as to cause the MEGACYCLES dial reading to shift from 120 to 140.			
17	Reset tuning control for maximum output-meter indication at MEGACYCLES dial reading of approximately 130 mc. Set C. W. AND MANUAL-MANUAL-A.V.C. switch to C. W. AND MANUAL, and repeat operation 3.			
18	Repeat operation 12.			
19	Repeat operation 13.			
20	Repeat operation 14.			
21	Repeat operation 15.			
22	Repeat operation 16.			
23	Reset tuning control for maximum output-meter indication at MEGACYCLES dial reading of approximately 130 mc. Set C. W. AND MANUAL-MANUAL-A. V. C. switch to A. V. C., and repeat operation 3.			
24	Repeat operation 12. LINE jack.			
25	Repeat operation 13.			
26	Repeat operation 14.			
27	Repeat operation 15.			
28	Repeat operation 16.			
29	Reset tuning control for maximum output-meter indication of MEGACYCLES dial reading of approximately 130 mc. Set C. W. AND MANUAL-MANUAL-A. V. C. switch to MANUAL. Remove headphones plug from MONITOR jack, and insert into			

CONCLUSIONS

1. What is the purpose of the POWER ON switch?
2. What is the purpose of the SUPPLY VOLTAGE control?
3. What circuit does the D.C. FUSE protect?
4. How is the over-all power supply protected?
5. What is the purpose of the THRESHOLD SENSITIVITY control?
6. In what positions of the C.W. AND MANUAL-MANUAL-A.V.C. switch is the THRESHOLD SENSITIVITY control in use?
7. In what positions of the C.W. AND MANUAL-MANUAL-A.V.C. switch is the R.F. GAIN INCREASE control in use?
8. What is the normal setting of the THRESHOLD SENSITIVITY control?
9. What is the purpose of the R.F. GAIN INCREASE control?
10. What is the purpose of the AUDIO GAIN INCREASE control?
11. What is the purpose of the ATTENUATION control?
12. What is the purpose of the C.W. TONE CONTROL?
13. In what position of the C.W. AND MANUAL-MANUAL-A.V.C. switch is the C.W. TONE CONTROL in use?
14. Does the panel meter indication dip in all three positions of the C.W. AND MANUAL-MANUAL-A.V.C. switch when a signal is being tuned in on the receiver?
15. Does the output meter indicate the output of the receiver when the headphones are plugged into the LINE jack?

LECTURE No. 3

FUNCTIONAL BLOCK ANALYSIS

In analyzing the operation of Radio Receiver BC-639-A, refer to the block diagram in figure 15. In this diagram, the blocks represent the BC-639-A circuits which are listed below:

1. Radio-frequency-amplifier circuit.
2. H-f oscillator circuit.
3. Double circuit.
4. Mixer circuit.
5. Intermediate-frequency-amplifier circuit (3-stage).
6. Detector circuit.
7. Automatic-volume-control circuit.
8. Audio-amplifier circuit (2-stage).
9. Beat-frequency (c-w) oscillator circuit.

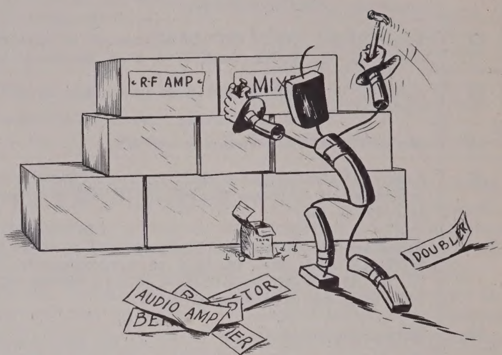
In a typical installation, Radio Receiver BC-639-A operates in the following manner:

Very-high-frequency radio signals within the range of 100 to 156 megacycles are received by the antenna, which is connected to the antenna socket at the rear of the receiver. These signals are fed to the r-f amplifier circuit through a short piece of coaxial transmission line that extends from the antenna socket to a coil located on the r-f assembly (see figure 9). The r-f circuit, which uses a variable-mu r-f pentode tube, type VT-203 (9003), selects the desired signal from the many which may be present at the antenna, and amplifies it. This amplified signal is then fed to the mixer circuit, which also uses a variable-mu r-f pentode tube, type VT-203 (9003).

In the mixer circuit, the signal is mixed with another r-f signal from a local source, whose frequency is always maintained at a value which differs from that of the incoming signal by 12 megacycles. In the mixing process, heterodyne action between the incoming signal and the local r-f signal produces a third signal which is known as the intermediate-frequency (i-f) signal. This i-f signal has all the characteristics of the incoming h-f signal with the exception of frequency. The frequency is 12 megacycles, or the difference between the frequencies of the two signals that were mixed. The mixer circuit, in addition to the mixing process, provides a certain amount of rejection for undesired signals. The components of both the mixer circuit and the r-f amplifier circuit are located on the r-f assembly (see figure 9).

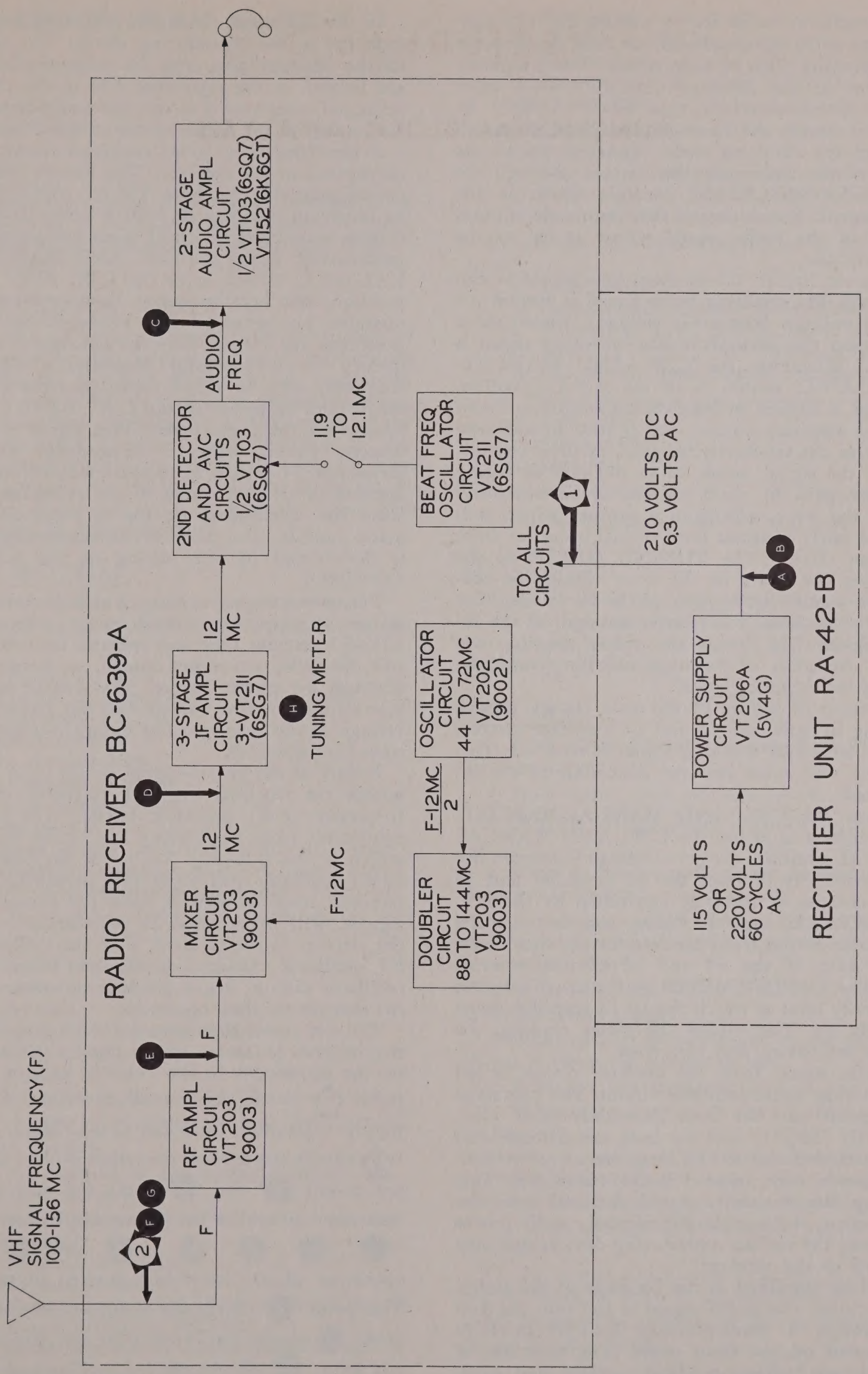
The source of the local r-f signal is the h-f oscillator circuit, which operates in conjunction with a doubler circuit. The h-f oscillator circuit uses a triode tube, type VT-202 (9002), and generates a signal whose frequency may be varied from 44 to 72 megacycles. This frequency is maintained at a value which is equal to one-half the difference between the incoming-signal frequency and 12 megacycles.

The signal from the h-f oscillator circuit is fed to the doubler circuit, which uses a variable-mu r-f pentode tube, type VT-203 (9003). In this circuit the frequency of the h-f oscillator signal is doubled, making it equal to the difference between the incoming-signal frequency and 12 megacycles. The signal from the doubler circuit is then applied, by means of inductive coupling, to the mixer circuit, where it mixes with the incoming signal, as previously explained. All the components of the doubler and h-f oscillator circuits are located on the oscillator assembly (see figure 9).



The tuning of the r-f circuit, the mixer circuit, the h-f oscillator circuit, and the doubler circuit is accomplished by means of a single tuning control, which is located on the front panel. Mechanical coupling of the tuning mechanisms of these circuits to the tuning control maintains the correct tuning relationship between these circuits at all times. This relationship is important, since it determines whether the maximum i-f signal, which is the difference between the frequency of the incoming signal and the signal from the local r-f source, will be maintained over the entire operating band of the receiver.

When both signals, the signal from the doubler circuit and the signal from the r-f circuit, are present in the mixer circuit in the correct relationship, a difference frequency of 12 megacycles (the i-f signal) is produced. This signal is fed into a three-stage i-f amplifier circuit, which is tuned to 12 megacycles. Each i-f stage in the circuit uses a remote cut-off pentode tube, type VT-211 (6SG7). The i-f amplifier circuit is designed to have a bandwidth of 140 kilocycles within the range of 11.3 to 12.7 megacycles; thus any signal that lies within the bandwidth of the amplifier circuit will be amplified. The over-all gain (maximum level of sensitivity) of the i-f amplifier circuit is preset by adjustment of the THRESHOLD SENSITIVITY control, located on the front panel. The TUNING METER, also on the front panel, indicates the level to which the sensitivity of the circuit has been set. The circuit components and tuning adjustments for all three stages of the amplifier circuit are located along the rear of the receiver chassis (see figure 9).


RADIO RECEIVER BC-639-A
VHF
SIGNAL FREQUENCY (F)
100-156 MC
2
F
G
F
RF AMPL
CIRCUIT
VT203
(9003)
E
F
MIXER
CIRCUIT
VT203
(9003)
D
12
MC
3-STAGE
IF AMPL
CIRCUIT
3-VT211
(6SG7)
12
MC
H
TUNING METER
2ND DETECTOR
AND AVC
CIRCUITS
1/2 VT103
(6SQ7)
AUDIO
FREQ
C
2-STAGE
AUDIO AMPL
CIRCUIT
1/2 VT103 (6SQ7)
VT152 (6K6GT)
F-12MC
DOUBLER
CIRCUIT
88 TO 144MC
VT203
(9003)
F-12MC
2
OSCILLATOR
CIRCUIT
44 TO 72MC
VT202
(9002)
11.9
TO
12.1 MC
BEAT FREQ
OSCILLATOR
CIRCUIT
VT211
(6SG7)
TO ALL
CIRCUITS
1
210 VOLTS DC
6.3 VOLTS AC
A
B
POWER SUPPLY
CIRCUIT
VT206A
(5V4G)
115 VOLTS
OR
220 VOLTS
60 CYCLES
AC
RECTIFIER UNIT RA-42-B

TP9-1319

Figure 15. Block Diagram of Radio Receiver BC-639-A

After amplification in the i-f circuit, the 12-megacycle signal is fed simultaneously to both the detector and a-v-c circuits. Each of these circuits uses a separate diode plate in the detector—1st-audio—a-v-c tube, which is a duo-diode-triode, type VT-103 (6SQ7). In the detector circuit, the 12-megacycle signal is demodulated, and the resulting audio signal is fed to the 1st stage of the audio-amplifier circuit, through the AUDIO GAIN INCREASE control, which is the volume control. The setting of this control determines the value of the audio signal which is fed to the amplifier circuit.

In the a-v-c circuit, the 12-megacycle signal is also demodulated. The resulting audio signal is filtered out and a d-c voltage (the a-v-c voltage) whose value depends upon the strength of the incoming signal is developed. Whenever the C.W. AND MANUAL-MANUAL-A.V.C. switch is in the A.V.C. position, this voltage is applied to both the r-f amplifier circuit and the i-f amplifier circuit, and is used to automatically control the sensitivity, or gain, of these circuits. Whenever the signal varies, as in the case of fading signals, the gain of these circuits is automatically varied by the a-v-c voltage in a manner which will maintain a fairly constant level of audio output from the detector circuit. The TUNING METER on the panel shows the effect of the a-v-c voltage in controlling the sensitivity, or gain, of the 1st i-f amplifier stage, and thus shows the relative strength of the incoming signal. The lower the meter reading, the lower the sensitivity of the stage and the greater the strength of the incoming signal.

In the event of failure of the a-v-c circuit, serious overloading of both the r-f and i-f amplifier circuits will occur whenever a strong signal is received. This overloading will cause extreme distortion of the received signal.

Whenever the C.W. AND MANUAL-MANUAL-A.V.C. switch is in either the C.W. AND MANUAL or MANUAL position, the a-v-c voltage is shorted out and the sensitivity of both the r-f amplifier and i-f amplifier circuits is manually controlled by the R.F. GAIN INCREASE control. Fading signals cause the level of audio output from the detector circuit to vary, since the gain of the r-f and i-f circuits remains constant. The TUNING METER on the panel indicates the sensitivity level at which the 1st i-f amplifier stage is manually set. The higher the meter reading, the higher the sensitivity, and vice versa.

The audio signal from the detector circuit is fed into a two-stage audio-amplifier circuit. The first stage of this circuit uses the same duo-diode-triode tube, type VT-103 (6SQ7), used for both the detector and a-v-c circuits, and the second stage uses a power-amplifier pentode tube, type VT-152 (6K6GT). This circuit amplifies the audio signal obtained from the detector circuit, and supplies the necessary audio power for operating the various reproducing devices that may be attached to the receiver.

After being amplified in the 1st stage of the audio-amplifier circuit the audio signal is fed into the 2nd stage, through a three-position ATTENUATION switch located on the front panel. The positions of this switch are marked —12DB, —6DB, and 0DB. The setting of this switch determines the amount by which the audio signal from the 1st stage will be attenuated before it reaches the 2nd stage of the audio-amplifier circuit.

In the 2nd stage, the signal is further amplified and then fed to the reproducing device. The components of the detector a-v-c and 1st-audio-amplifier circuits are located at the right-rear side of the chassis. The principal components of the 2nd-audio-amplifier stage are located in the center of the chassis.

A beat-frequency (c-w) oscillator circuit is also incorporated in the receiver. This circuit uses a remote cut-off pentode tube, type VT-211 (6SG7). It is used in receiving c-w signals, which under ordinary conditions would not be heard, since c-w signals have no modulation. When the C.W. AND MANUAL-MANUAL-A.V.C. switch is in the C.W. AND MANUAL position, the beat-frequency (c-w) oscillator circuit operates, but when it is in either of the other two positions, the circuit does not operate. The beat-frequency (c-w) oscillator generates a signal whose frequency may be varied manually from 11.9 to 12.1 megacycles by means of the C.W. TONE CONTROL, located on the front panel. This signal is fed to the detector circuit, where it heterodynes with the 12-megacycle i-f signal, to produce a third signal which appears as an audio tone in the reproducing device. Thus the intelligence on the received c-w signal is made audible. The pitch of the audio tone produced is determined by the setting of the C.W. TONE CONTROL.

The power-supply circuit, which is used to supply all the receiver circuits with power, uses a VT-206A (5V4G) rectifier tube and operates from either a 115-volt, 60-cycle, a-c power source, or from a 220-volt, 60-cycle, a-c power source. This circuit supplies the 6.3-volt a-c filament voltage and the 210-volt, d-c B+ voltage to the receiver. The circuit is located in Rectifier Unit RA-42-B.

Failure of the power-supply circuit or of any circuit within the receiver, with the exception of the beat-frequency (c-w) oscillator circuit, will prevent the equipment from performing any of the functions for which it was intended. Failure of the beat-frequency (c-w) oscillator will cause only partial failure of the receiver, since all signals, with the exception of c-w signals, will be received in the normal manner. All the circuits in the receiver, with the exception of the h-f oscillator circuit and the beat-frequency (c-w) oscillator circuit, are dependent on other circuits in the receiver for their operation.

The test points shown on the block diagram indicate the relative points at which checks should be made on the equipment in the event of failure. Major test point ① checks the over-all operation of the power supply (Rectifier Unit RA-42-B). Major test point ② checks the over-all operation of the receiver. Key test points Ⓐ and Ⓑ check the operation of the individual circuits of the power supply. Key test points Ⓒ, Ⓓ, Ⓔ, Ⓕ, Ⓖ, and Ⓗ check the operation of the individual circuits of the receiver. Test point Ⓒ checks the audio-amplifier circuit; test point Ⓓ checks the i-f amplifier and detector circuits; test point Ⓔ checks the h-f oscillator, doubler, and mixer circuits; test point Ⓕ checks the r-f amplifier circuit; test point Ⓖ checks the beat-frequency (c-w) oscillator; and test point Ⓗ checks the a-v-c circuit.

LESSON PLAN No. 3

TIME ALLOTTED: ½ HR.

SUBJECT

Functional block analysis.

OBJECTIVE

To provide the trainee with a good understanding of the functions of each circuit, its relation to other circuits, and its location within the physical units of the equipment.

INTRODUCTION

An equipment generally consists of a number of interconnected circuits, with each circuit performing a certain specific operation. Failure of any one circuit usually results in the absence of a needed function, which causes either complete or partial failure of the entire equipment. Therefore, a knowledge of the purpose of each circuit, its relation to other circuits, and its location within the physical units of the equipment is very important, and is the basis for a thorough understanding of any equipment.

SUBJECT MATERIAL

1. Draw the block diagram of the receiver.

2. Give the titles of the circuits which the blocks represent.

3. Discuss the r-f circuit.
   a. Signal path from antenna to r-f circuit.
   b. Tubes used.
   c. Uses of circuit.
      (1) Amplification.
      (2) Signal selection.

4. Discuss the mixer circuit.
   a. Tube used.
   b. Uses of circuit.
      (1) Mixing process.
      (2) Undesired-signal rejection.

5. Give the physical location of both the r-f and mixer circuits.

6. Discuss the h-f oscillator circuit.
   a. Source of local r-f signal.
   b. Tube used.
   c. Purpose of h-f oscillator circuit.

7. Discuss the doubler circuit.
   a. Tube used.
   b. Purpose of doubler circuit.

8. Give the physical location of both the oscillator and doubler circuits.

9. Give the purpose of the tuning control.

10. Discuss the i-f circuit.
    a. Source of i-f signal.
    b. Tubes used.
    c. Amplifier bandwidth.
    d. Purpose of i-f circuit.
    e. Purpose of both THRESHOLD SENSITIVITY control and TUNING METER.
    f. Physical location of circuit components.

11. Discuss the detector and a-v-c circuit.
    a. Tube used.
    b. Purpose of detector circuit.
    c. AUDIO GAIN INCREASE control.
    d. Purpose of a-v-c circuit.
    e. TUNING METER indications.
    f. Consequences of a-v-c circuit failure.
    g. Purpose of C.W. AND MANUAL-MANUAL-A.V.C. switch.

12. Discuss the audio-amplifier circuit.
    a. Tubes used.
    b. Purpose of audio-amplifier circuit.
    c. Purpose of ATTENUATION switch.
    d. Physical location of circuit components.

13. Discuss the beat-frequency (c-w) oscillator circuit.
    a. Tube used.
    b. Purpose and function of oscillator circuit.
    c. Purpose of C.W. TONE CONTROL.
    d. Effect of C.W. AND MANUAL-MANUAL-A.V.C. switch upon circuit operation.

14. Discuss the power-supply circuit.
    a. Tube used.
    b. Purpose of circuit.
    c. Location.

15. State the consequences of any circuit failure.

16. Give the purpose of the test points.

CONCLUSION

In the event of equipment failure, a mental division of the equipment into the functional sections and circuits indicated by the block diagram will aid in the localization of trouble.

ORAL QUIZ

1. How many different functional circuits does the receiver have?

2. How many tubes are used in the receiver?

3. What is the frequency range of the h-f oscillator circuit?

4. What is the purpose of the doubler circuit? Where is it located?

5. Is the relationship between the incoming signal and the r-f signal produced by the h-f oscillator circuit important? Why?

6. What is the bandwidth of the i-f amplifier? What is the frequency range?

7. What circuits are controlled by the a-v-c voltage? When is the a-v-c voltage in use?

8. What are the symptons of a-v-c circuit failure?

9. What is the purpose of the beat-frequency (c-w) oscillator?

10. How is the pitch of the tone which is produced by heterodyne action between the incoming signal and the beat-frequency-oscillator signal varied?

11. What voltage does the power supply furnish to the receiver?

12. Failure of which receiver circuit will cause only partial failure of the over all equipment?

13. What is the purpose of the test points indicated on the block diagram?

14. What is major test point 1 used for? Major test point 2? Key test point E?

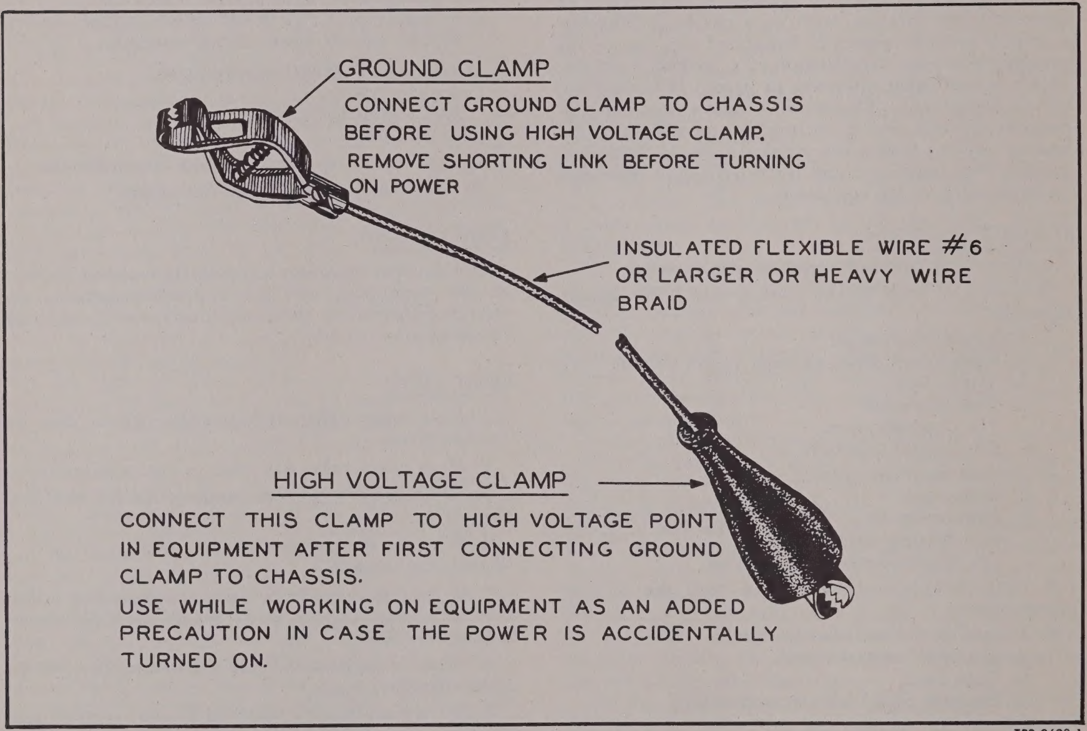
(Continued on page 28)

SAFETY PRECAUTIONS

It is the duty of all personnel engaged in the installation, operation, and maintenance of this equipment, or engaged in the training of other personnel on this equipment, to become familiar with the following safety precautions:

1. Do not rely on built-in safety devices.
2. Use rubber gloves when applicable.
3. Keep your feet clear of objects on the floor.
4. Stand on a dry rubber mat.
5. Keep one hand behind you, or in your pocket.
6. Have another person, qualified in first aid for electrical shock, present at all times.

Remember that men are always injured or killed by high-voltage equipment which is assumed to be off. Take nothing for granted. Make certain that the power is off by securing the power-line switch in its OFF position.


GROUND CLAMP
CONNECT GROUND CLAMP TO CHASSIS BEFORE USING HIGH VOLTAGE CLAMP. REMOVE SHORTING LINK BEFORE TURNING ON POWER
INSULATED FLEXIBLE WIRE #6 OR LARGER OR HEAVY WIRE BRAID
HIGH VOLTAGE CLAMP
CONNECT THIS CLAMP TO HIGH VOLTAGE POINT IN EQUIPMENT AFTER FIRST CONNECTING GROUND CLAMP TO CHASSIS.
USE WHILE WORKING ON EQUIPMENT AS AN ADDED PRECAUTION IN CASE THE POWER IS ACCIDENTALLY TURNED ON.

TP9-9692-1

FIRST AID

Do These Three Things First in Any Emergency Requiring First Aid

1. **Send for a doctor or carry the victim to a doctor.**
2. **Keep victim warm, quiet, and flat on his back.**
3. **If breathing has stopped, apply artificial respiration. Stop all serious bleeding.**

When, from any cause whatever, breathing has stopped, apply artificial respiration immediately and continue WITHOUT STOPPING until normal breathing returns, or a doctor pronounces the victim dead. SPEED IN BEGINNING ARTIFICIAL RESPIRATION IS ESSENTIAL.

FIRST AID (Cont.)

The Prone Pressure Method of Artificial Respiration

If Due to Electric Shock

1. PROTECT YOURSELF with DRY insulating material.

2. BREAK THE CIRCUIT by opening the power switch or pulling the victim free of the live conductor. DON'T TOUCH THE VICTIM WITH YOUR BARE HANDS UNTIL THE CIRCUIT IS BROKEN.

3. SPREAD DRY BLANKET ON THE GROUND, and roll victim to center of blanket with his arms extended over his head, so that he lies FACE DOWN on blanket.

4. BEND ONE OF THE VICTIM'S ARMS at the elbow and rest victim's cheek on the back of his hand.

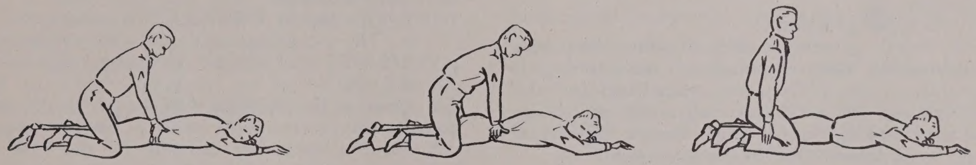
5. REMOVE FALSE TEETH, gum, candy, tobacco, food, etc., from victim's mouth.

6. LOOSEN ALL TIGHT CLOTHING, as belts or collars.

7. COVER VICTIM LOOSELY by wrapping the ends of the blanket around him.

8. STRADDLE VICTIM across thighs.

9. PLACE THE PALMS OF YOUR HANDS ON VICTIM'S BACK so that the little fingers of each hand just touch the victim's lowest ribs.



(1) Straddle victim across thighs. Place the palms of your hands on the victim's back so that the little fingers of each hand just touch the victim's lowest ribs.

(2) Keep your arms stiff and straight and swing your body forward, allowing your weight to bear down on victim. DO NOT PUSH OR USE FORCE.

(3) Swing back at once to relieve pressure, and then continue the rhythmic application of alternate pressure and release.

Blanket is not shown in above drawings for the sake of clarity.

5LO-03811

10. KEEP YOUR ARMS STIFF AND STRAIGHT and swing your body forward, allowing your weight to bear down on the victim.
11. DO NOT PUSH OR USE FORCE.
12. SWING BACK AT ONCE TO RELIEVE PRESSURE.
13. REPEAT Step 10.
14. REPEAT Step 12.
15. CONTINUE as above, maintaining a steady rhythm until victim regains consciousness or is pronounced dead by a doctor.
16. CONTINUE ARTIFICIAL RESPIRATION even after victim begins to breathe, and until he becomes conscious.
17. IF BREATHING STOPS AGAIN, continue artificial respiration at once.
18. DO NOT GIVE UP HOPE of reviving the victim. Four hours or more of continuous application of artificial respiration may be required before consciousness returns.

19. NEVER TRY TO FORCE LIQUIDS down an unconscious person's throat. He will drown.

20. ALWAYS WAIT UNTIL CONSCIOUSNESS RETURNS before administering liquid stimulants.

21. RECOMMENDED STIMULANTS ARE: Hot, black coffee. Strong, hot tea. Aromatic spirits of ammonia, one teaspoonful to a glass of water.

22. GIVE ONLY ONE STIMULANT, which should be sipped slowly.

23. ALCOHOLIC DRINKS are not recommended, unless absolutely nothing else is available.

24. When VICTIM HAS RETURNED TO CONSCIOUSNESS, allow him to lie quietly where he is for at least one hour, taking care that he is well covered and free from worry.

25. IF POSSIBLE, CARRY, OR HAVE HIM CARRIED TO A DOCTOR.

EXPERIMENT No. 3

TIME ALLOTTED: 3 HR.

SUBJECT

Method of checking the equipment and circuit functions.

OBJECTIVE

To familiarize the trainee with the functions of each circuit in the receiver and power supply, and with the method of determining whether the circuits are functioning.

EQUIPMENT REQUIRED

1 Radio Receiver BC-639-A.
1 Rectifier Unit RA-42-B.
1 Power-supply cable equipped with two Jones connector sockets.
1 D-c voltmeter (20,000 ohms-per-volt sensitivity).
1 A-c voltmeter.
1 Headset.
1 Audio signal generator.
1 R-f signal generator with accurate frequency calibration, both unmodulated and 1000-cycle modulated output, frequency range which includes 12 mc. and 100 to 156 mc., adjustable percentage of modulation, low (70-ohm) output impedance, and a calibrated OUTPUT attenuator.

INSTRUCTIONS

Use care in handling the test equipment. Make only the tests outlined in the procedure. Do not change the positions of the operating controls on either the receiver or the test equipment unless directed to do so in the procedure. Do not apply power to the receiver unless a load is connected across its output.

1. Remove the receiver and power-supply units from the dust covers.

2. Interconnect the power supply and the receiver, using the power-supply cable equipped with the two Jones connector sockets.

3. Insert the headset plug into the MONITOR jack on the receiver front panel.

4. Connect the power-supply unit to the power source.

5. Operate the POWER ON switch on the power supply to on.

6. The over-all operation of the power-supply unit and its distribution network may be checked by measuring the voltages delivered to the receiver at power-supply plug 263 (major test point ①). This check is made in the following manner:

a. Connect the positive lead of the d-c voltmeter (500-volt range) to terminal 10 of receiver-power-supply plug 263; connect the negative lead to the chassis. CAUTION: High voltage is present at terminal 10. Avoid contact with this terminal.
b. Connect an a-c voltmeter (30-volt range) between terminal 8 of plug 263 and the chassis.
c. The d-c voltmeter should indicate 210 volts and the a-c voltmeter, 6.3.

7. The operation of the individual circuits within the power supply may be checked without the distribution network being connected by measuring the output voltages of each circuit at power-output plug 357 (key test points Ⓐ and Ⓑ). These checks are made in the following manner:

a. Operate the POWER ON switch to off, and disconnect the power-supply cable from the power supply.
b. Connect the positive lead to a d-c voltmeter (500-volt range) to terminal 10 (test point Ⓑ on power-output plug 357; connect the negative lead to the chassis. CAUTION: High voltage is present at terminal 10. Avoid contact with this terminal.
c. Connect an a-c voltmeter (30-volt range) between terminal 8 (test point Ⓐ) of plug 357 and the chassis.
d. Operate the POWER ON switch to on.
e. The d-c voltmeter should read approximately 210 volts and the a-c voltmeter, approximately 6.3 volts.

8. Operate the POWER ON switch to off, and reconnect the power-supply cable to the power supply.

9. Set the operating controls on the receiver as follows:

CONTROL	POSITION
ATTENUATION switch	0 DB
C. W. TONE CONTROL	Center line
R. F. GAIN INCREASE control	Maximum clockwise
C. W. AND MANUAL-MANUAL-A. V. C. switch	MANUAL
AUDIO GAIN INCREASE control	Maximum clockwise
Tuning control	To position where MEGACYCLES dial indicates 130 mc.

10. Operate the POWER ON switch on the power-supply unit to on.

11. The over-all operation of the receiver may be checked by introducing a 130-megacycle signal into the antenna receptacle of the receiver (major test point ②), and noting the intensity and type of sound which is produced in the headset. In order to make this check, the signal generator must be prepared for use as follows:

a. Set both the CARRIER control and the MODULATION control to minimum (extreme counterclockwise position).
b. Connect the signal generator to a power source of the proper voltage.
c. Set the operating controls on the signal generator to the following positions:

Set POWER switch to ON.
Set MODULATION switch to INTERNAL.
Set generator output frequency to 130 mc.

Set r-f CARRIER to proper level.
Set MODULATION control to 30%.
Set r-f OUTPUT control to 500 microvolts.

12. Check the over-all operation of the receiver as follows:

a. Apply the modulated output of the signal generator to the antenna-input receptacle at the rear of the receiver (major test point 2).

b. A loud, clear signal should be heard in the headset.

NOTE: In some instances it may be necessary to adjust the receiver tuning control slightly in order to obtain the signal.

c. On the receiver, set the C.W. AND MANUAL-MANUAL-A.V.C. switch to A.V.C.

d. A loud clear signal should be heard in the headset, and the panel-meter reading should drop.

e. On the signal generator, set the MODULATION switch to OFF.

f. On the receiver, set the C.W. AND MANUAL-MANUAL-A.V.C. switch to C.W. AND MANUAL, and slowly vary the C.W. TONE CONTROL from its center-line setting, in either direction.

g. A loud, clear tone which varies in pitch with the position of the C.W. TONE CONTROL should be heard in the headset.

13. On the receiver, set the C.W. AND MANUAL-MANUAL-A.V.C. switch to the MANUAL position, and disconnect the signal generator from major test point 2.

14. The operation of the audio-frequency-amplifier circuit may be checked as an individual circuit by applying a 1000-cycle audio signal to pin 4 (test point Ⓒ of the detector a.v.c.-1st audio amplifier tube, VT-103 (6SQ7). Make the check as follows:

a. Connect the ungrounded output lead of the audio signal generator through a .1-uf capacitor to pin 4 (test point Ⓒ); connect the grounded lead to the receiver chassis. Adjust the audio signal generator for a 1000-cycle signal, and its output control for a weak output.

b. A loud, clear tone should be heard in the headset.

15. The operation of the i-f amplifier and detector circuits may be checked as an individual circuit by applying a modulated 12-megacycle signal to pin 1 (test point Ⓓ) of the mixer tube, VT-203 (9003). Make the check as follows:

a. Connect the ungrounded output lead of the signal generator through a .1-uf capacitor to pin 1 (test point Ⓓ); connect the grounded lead to the receiver chassis.

b. Set signal generator output frequency to 12 mc. Set all of the other controls to the positions given in step 11.

c. A loud, clear signal should be heard in the headset.

16. The operation of the h-f oscillator, doubler, and mixer circuits may be checked as an individual circuit by applying a modulated 130-mc. signal to pin 5 (test point Ⓔ of the r-f amplifier tube, VT-203 (9003). Make the check in the following manner:

a. Connect the ungrounded output lead of the signal generator through a .1-uf. capacitor to pin 5 (test point Ⓔ); connect the grounded lead to the receiver chassis.

b. Set all of the signal-generator controls to the positions given in step 11.

c. A loud, clear signal should be heard in the headset.

17. The operation of the r-f amplifier circuit may be checked as an individual circuit by applying a modulated 130-mc. signal to the antenna-input receptacle of the receiver (test point Ⓕ). Make the check as follows:

a. Connect the ungrounded output lead of the signal generator to the antenna-input receptacle of the receiver.

b. Set all of the signal-generator controls to the positions given in step 11.

c. A loud, clear signal should be heard in the headset.

18. The operation of the beat-frequency-oscillator circuit may be checked as an individual circuit by applying an unmodulated 130-mc. signal to the antenna-input receptacle (test point Ⓖ) of the receiver. Make the check as follows:

a. Connect the signal generator to the receiver as in step 17.a.

b. On the signal generator, set the MODULATION switch to OFF. Set all of the other controls to the same positions as in step 11.

c. On the receiver, set the C.W. AND MANUAL-MANUAL-A.V.C. switch to the C.W. AND MANUAL position, and slowly vary the setting of the C.W. TONE CONTROL to either side of the center-line position.

d. A loud, clear tone which varies in pitch with the position of the C.W. TONE CONTROL should be heard in the headset.

19. The operation of the automatic-volume-control circuit may be checked as an individual circuit by applying a strong, modulated 130-mc. signal to the antenna-input receptacle of the receiver. Make the check as follows:

a. Connect the signal generator to the receiver as in step 17.a.

b. On the receiver, set the C.W. AND MANUAL-MANUAL-A.V.C. switch to the A.V.C. position.

c. On the signal generator, set the MODULATION switch to INTERNAL, and increase the OUTPUT control setting to maximum. All other controls remain in the same positions as in step 11.

d. The panel-meter reading should decrease to approximately 1 ma. and the sound in the headset should be loud and clear.

20. Disconnect the signal generator, and operate the POWER-ON switch on the power supply to off.

CONCLUSIONS

1. In which unit (receiver or power supply) is major test point 1 located?

2. What unit does major test point 1 check?

3. What circuit does test point Ⓐ and test point Ⓑ check?

4. At which test points must care be exercised in order to avoid shock?

5. Which test point is used in checking the over-all operation of the receiver?

6. In what circuit of the receiver is key test point Ⓒ located, and what circuit does it check?

7. What type of signal is introduced at key test point Ⓓ in checking the operation of the i-f amplifier circuit?

8. How does the use of test point Ⓔ check the operation of the h-f oscillator, doubler, and mixer circuits?

9. What test is used to check the operation of the beat-frequency oscillator?

10. What indication on the receiver shows whether the a-v-c circuit is functioning?

LECTURE No. 4

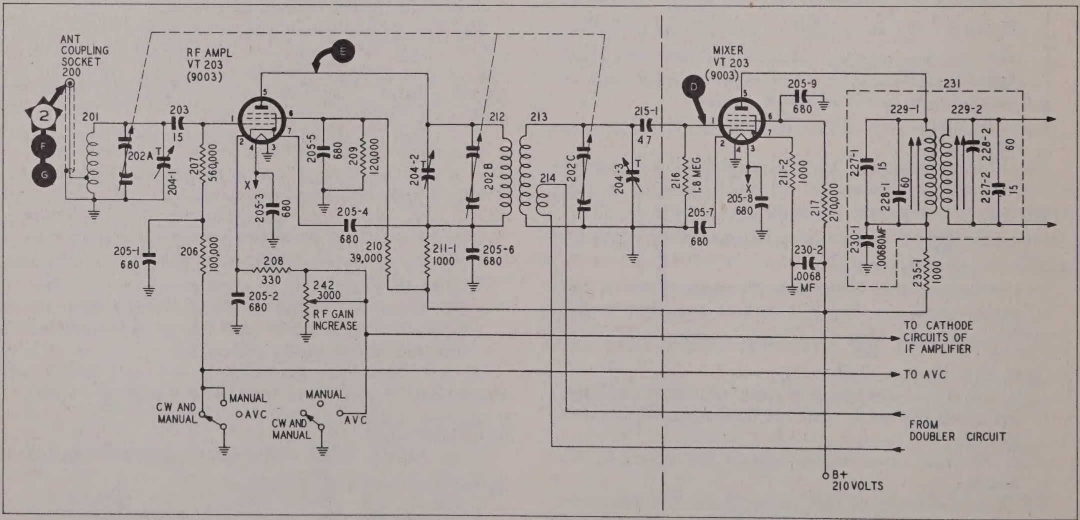
CIRCUIT ANALYSIS OF R-F AMPLIFIER

The r-f amplifier circuit used in the BC-639-A receiver selects and amplifies the signals received by the antenna, and improves both the image-rejection ratio and the signal-to-noise ratio of the receiver. The r-f amplifier circuit, which is part of the r-f assembly (see figures 9 and 17), is shown in block form in figure 15 and in schematic form in figure 16. This circuit, as indicated on the schematic diagram, is a single-stage tuned-grid, tuned-plate amplifier which uses a super-control r-f pentode tube, type VT-203 (9003).

When a v-h-f signal is introduced into the antenna-grid coil, 201, through the short piece of coaxial line connected between the antenna-coupling socket 200, at the left rear of the receiver chassis, and the antenna-grid coil 201 on the r-f assembly, a radio-frequency voltage is caused to appear across the upper portion of the coil, due to autotransformer action. This voltage is applied to the control grid of the r-f amplifier tube, through the 15-uuf. coupling capacitor, 203.

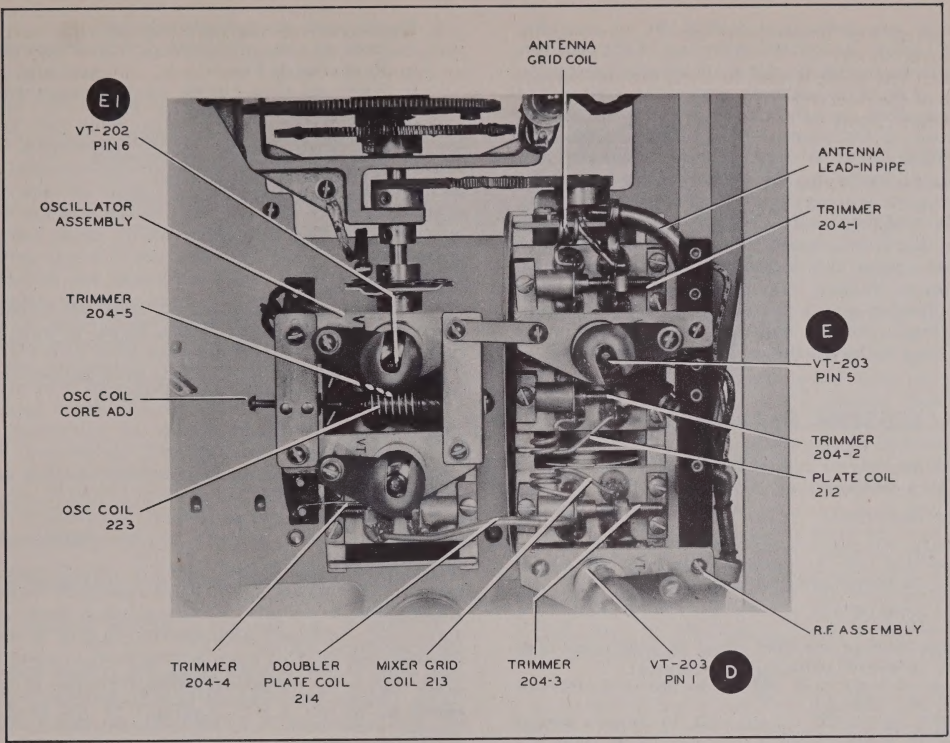
Voltage amplification in the tube results in the presence of a fairly high level output-signal voltage across the plate coil, 212, of the tuned-output load. Inductive coupling between this coil and the grid coil, 213, of the mixer circuit is used to introduce the amplified signal into the mixer circuit.

The short piece of coaxial transmission line which connects the antenna-coupling socket, 200, to the antenna-grid coil, 201, minimizes the possibility of the introduction of the incoming signal into any other circuit except the r-f circuit. This line is connected to a point on the low end of the antenna-grid coil in order to provide the proper load impedance of 70 ohms to the dipole antenna, which is normally used with the receiver. The antenna-grid coil, 201, is tuned over the frequency range of 100 to 156 megacycles by means of variable capacitor 202A, and the plate coil, 212, by means of variable capacitor 202B. A concentric-type trimmer capacitor 204-1, is connected in parallel with tuning capacitor 202A, and a similar capacitor, 204-2 is connected in parallel with tuning capacitor 202B.


ANT COUPLING SOCKET 200
RF AMPL VT 203 (9003)
E
2
F
G
201
202A
204-1
203
15
207 560,000
205-1 680
206 100,000
205-3 680
X
208 330
205-2 680
242 3000
R F GAIN INCREASE
205-5 680
209 120,000
205-4 680
210 39,000
204-2
202 B
212
211-1 1000
205-6 680
213
214
202C
215-1 47
204-3
T
MIXER VT 203 (9003)
D
216 1.8 MEG
205-7 680
205-8 680
205-9 680
211-2 1000
217 270,000
230-2 .0068 MF
231
229-1
229-2
227-1 15
228-1 60
230-1 .00680MF
235-1 1000
228-2 60
227-2 15
TO CATHODE CIRCUITS OF IF AMPLIFIER
TO AVC
FROM DOUBLER CIRCUIT
B+ 210 VOLTS
CW AND MANUAL
MANUAL
AVC
CW AND MANUAL
MANUAL
AVC

TP9-1320

Figure 16. Schematic Diagram of R-F-Amplifier and Mixer Circuits



225A

Figure 17. R-F and Oscillator Assemblies, Showing Locations of Components and Test Points

These trimmer capacitors are used to compensate for slight errors in circuit tracking. Both variable capacitors 202A and 202B, in conjunction with variable capacitor 202C (which tunes the mixer-grid coil, 213) form a three-gang tuning capacitor, with an ungrounded rotor that is mechanically coupled to the tuning dial.

The 15-uuf capacitor, 203, in the grid circuit not only provides a path for the signal but also prevents any d-c voltage which may be present on the grid of the tube from being shorted to ground through the antenna-grid coil 201.

When the C.W. AND MANUAL-MANUAL-A.V.C. switch is in either the C.W. AND MANUAL or MANUAL position, the 560,000-ohm resistor, 207, and the 100,000-ohm resistor, 206, in the grid circuit provide the grid with a high-resistance d-c path to ground. When the switch is in the A.V.C. position, these two resistors (in conjunction with the 680-uuf. capacitor, 205-1) act as a filter network for the a-v-c voltage which is applied to the grid of the tube. Minimum operating bias for the tube is furnished by the 330-ohm resistor, 208, in the cathode circuit. When the C.W. AND MANUAL-MANUAL-A.V.C. switch is in either the C.W. AND MANUAL or MANUAL position, manual control of the operating bias is provided by means of the 3000-ohm R.F. GAIN INCREASE control, 242, which is also in the cathode circuit. Controlling the operating bias of the tube controls the sensitivity of the circuit. When the C.W. AND MANUAL-MANUAL-A.V.C. switch is in the A.V.C. position, this control is shorted out and the sensitivity of the circuit is automatically controlled by the a-v-c voltage. The cathode and suppressor grid of the tube are connected together, and are kept at r-f ground potential by the 680-uuf. by-pass capacitor, 205-2.

The screen-grid operating voltage is obtained from the main high-voltage bus, through a 39,000-ohm resistor, 210. A 120,000-ohm resistor, 209, which is connected between the screen grid and ground, acts as a bleeder to stabilize the screen voltage. The screen grid is kept at r-f ground potential by the 680-uuf. by-pass capacitor, 205-5.

Plate voltage is obtained from the main high-voltage bus, through the plate-tank coil, 212, and the 1000-ohm plate-decoupling resistor, 211-1. The low end of the plate-tank coil is by-passed to ground by a 680-uuf. capacitor, 205-6, which keeps the low end of the coil at r-f ground potential, and is by-passed to the cathode by another 680-uuf. capacitor, 205-4, which provides the plate circuit with a short signal-return path, thus reducing the possibility of circuit interaction. The ungrounded side of the tube filament is kept at r-f ground potential by the 680-uuf. capacitor, 205-3, which is connected between the filament terminal and ground.

Failure of any component within the r-f amplifier circuit will affect the over-all operation of the receiver. The operation of the circuit may be checked by introducing a signal of known amplitude and of the proper frequency into the circuit at test point F, and then measuring the signal output of the circuit. Due to the difficulty of measuring the output of the r-f amplifier circuit, however, the output indication of the over-all receiver is generally used instead for indicating the condition of the circuit, after it has been determined first that all of the circuits between the r-f amplifier circuit and output of the receiver are in good operating condition. Failure to obtain the correct receiver output indication points to trouble in the r-f amplifier circuit. Simple voltage and resistance measurements are then used to locate the cause of circuit failure.

LESSON PLAN No. 4

TIME ALLOTTED: ½ HR.

SUBJECT

R-f amplifier circuit.

OBJECTIVE

To analyze the r-f amplifier circuit.

INTRODUCTION

The reduction of receiver noise is a primary consideration in every well-designed receiver.

SUBJECT MATERIAL

1. Purpose of the circuit.
2. Circuit location on the block diagram and on the schematic.
3. Type of circuit and tube used.
4. Signal path through the circuit.
5. Purpose of the individual circuit components.
   a. Short coaxial line.
   b. Grid and plate-circuit tuning components.
   c. Grid-circuit components.
   d. Cathode-circuit components.
   e. Screen-grid-circuit components.
   f. Plate-circuit components.
   g. Filament-circuit components.
6. Use of test point Ⓕ .

CONCLUSIONS

A receiver which uses an r-f amplifier circuit has much better image-rejection and signal-to-noise ratios than the receiver which does not have such a circuit. These advantages result from the preselection and amplification that occur in the r-f circuit.

ORAL QUIZ

1. Why is the antenna connected to the low end of the antenna-grid coil?

2. How is the r-f circuit tuned?

3. What is the purpose of the plate-to-cathode capacitor 205-4?

4. What is the purpose of the plate-filter resistor 211-1?

5. What is the purpose of bleeder resistor 209 in the screen-grid circuit?

6. How is the sensitivity of the circuit controlled when the C.W. AND MANUAL-MANUAL-A.V.C. switch is in the A.V.C. position? In the MANUAL position?

7. Does the amplifier ever operate at zero bias?

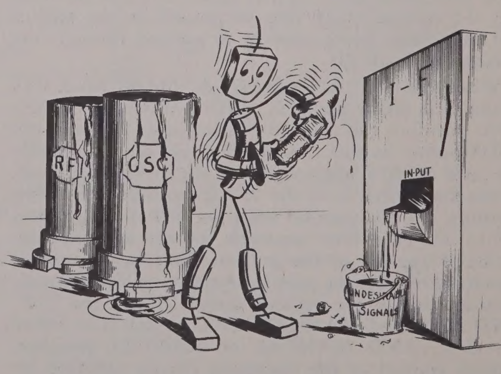
8. Why is it necessary to have a capacitor connected between the filament of the tube and the chassis?

LECTURE No. 5

CIRCUIT ANALYSIS OF MIXER

The mixer circuit used in the BC-639-A changes the frequency of the incoming signal to a fixed lower value, aids in rejecting undesired signals, and amplifies the desired signal. The mixer circuit, which is a part of the r-f assembly (see figures 9 and 17), is shown in block form in figure 15 and in schematic form in figure 16. This circuit uses a supercontrol r-f pentode tube, type VT-203 (9003), in a conventional pentode-type mixer circuit.

The incoming-signal voltage appearing across plate coil 212 in the r-f amplifier circuit is introduced into the mixer circuit by means of inductive coupling between the plate coil, 212, and the mixer-grid coil, 213. The coupling between these two coils is very critical, and may be varied by compressing or spreading the turns of either coil.



Another r-f signal voltage, whose frequency is 12 mc. lower than the incoming-signal frequency, is also introduced into the mixer circuit from the doubler circuit by means of inductive coupling between the doubler-circuit-plate coil, 214, and the mixer-grid coil,

213. The coupling between these two coils is not critical and hence, small changes in their positions can be tolerated.

These two signals are applied simultaneously to the grid of the mixer tube through coupling capacitor 215-1. Heterodyne action between these signals produces both sum and difference-frequency signals. These signals and the signals which were applied to the grid appear in the plate circuit of the tube. If the difference-frequency signal, which has the characteristics of the incoming signal, is selected and all of the other signals are rejected, the change in signal frequency will have been effected. Selection is accomplished through the use of a mixer-plate-load coil which is tuned to the difference-frequency (i-f) signal. Since the coil is a very low impedance to all frequencies except the i-f or difference frequency, the greatest voltage will be developed across the coil at the difference frequency, with practically no voltage developed by the other signal frequencies. The plate-load coil of the mixer tube is the primary coil of the 1st i-f transformer, 231. Inductive coupling between the primary and secondary of this transformer introduces the 12-mc. signal into the i-f amplifier circuit.

A high degree of image rejection is obtained over the entire frequency band of the receiver by the use of the three tuned circuits in the r-f section and by the use of a high intermediate frequency. The three tuned circuits increase the selectivity of the receiver, while the high intermediate frequency of 12 mc. provides a 24-mc. separation between the desired signal and the image signal. This is an assurance that the image signal will be relatively far from the peak of the resonance curve of the three tuned circuits. For example, when the frequency of the desired signal is 130 mc., the doubler supplies a frequency of 118 mc., to produce the 12-mc. i-f (difference) signal. In this case, the frequency of the image signal is 106 mc., which is 12 mc. below the doubler signal or 24 mc. below the desired signal. Therefore, the response of the tuned circuits to the image signal is very low.

The mixer-circuit grid coil, 213, is tuned to the incoming-signal frequency by capacitor 202C, which is part of the three-gang tuning capacitor that also tunes the grid and plate coils of the r-f amplifier circuit. A concentric-type trimmer capacitor, 204-3, is connected in parallel with tuning capacitor 202C, for use in compensating for slight errors in circuit tracking. The primary of the 1st i-f transformer, 231, is tuned to 12 mc. by means of a special powdered-iron core in the coil and a special 60-uuf. fixed capacitor, 228-1, which is paralleled by a small 15-uuf. temperature-compensating capacitor, 227-1. The temperature-compensating capacitor, 227-1, acts to keep the i-f transformer properly tuned when the receiver is subjected to temperature variations. Normally any adjustment of the tuning of the i-f transformer is made by adjusting the position of the powdered-iron core.

The 47-uuf. coupling capacitor, 215-1, provides a path for the signal to the grid of the mixer tube. The signal voltage is developed across the 1.8-megohm grid resistor, 216, which also provides the grid with a d-c path to ground. No a-v-c voltage is applied to the grid of this tube; its operating bias is furnished by the 1000-ohm resistor, 211-2, in the cathode circuit. The cathode and the suppressor grid of the mixer tube are connected together, and are kept at r-f ground potential by means of the 680-uuf. by-pass capacitor, 205-7. The operating voltage for the screen grid is obtained from the main high-voltage bus, through the 270,000-ohm resistor, 217. The screen grid is kept at r-f ground potential by the 680-uuf. by-pass capacitor, 205-9. Operating voltage for the plate is also obtained from the main high-voltage bus, through the 1000-ohm plate-filter resistor, 235-1, and the primary of the first i-f transformer, 231. The low end of the primary is kept at r-f ground potential by the .0068-uf. plate by-pass capacitor, 230-1. The .0068-uf. by-pass capacitor, 230-2, keeps the high voltage bus at r-f ground potential and, thus, prevents r-f energy from entering the power-supply circuit. The ungrounded side of the tube filament is also kept at r-f ground potential by the 680-uuf. filament by-pass capacitor, 205-8, which is connected between the filament terminal and ground. All leads to both resistors and by-pass capacitors are kept as short as possible, to minimize circuit interaction.

Failure of any component within the mixer circuit affects the over-all operation of the receiver. When a local r-f signal from the doubler circuit is present in the mixer circuit, the over-all operation of the mixer circuit may be checked by introducing a signal of known amplitude and of the proper frequency into the circuit at test point Ⓔ, and then measuring the signal output of the circuit. However, due to the difficulty of making such a measurement, the output of the over-all receiver is generally used for indicating the condition of the mixer circuit. This can be done by first determining that all of the other circuits between the mixer circuit and the output of the receiver are in good operating condition.

The check at test point Ⓔ will provide a specific receiver-output indication only when the oscillator, doubler, and mixer circuits are all operating normally. Failure to obtain the proper indication points to the need for other checks which will localize the trouble to a single circuit.

The mixer tube and its associated components, with the exception of the grid-circuit components, may be checked by applying a 12-mc. signal of known amplitude at test point Ⓓ. Failure to obtain the proper receiver output definitely points to trouble in the mixer circuit.

Assuming that both the oscillator and doubler circuits are functioning normally (specific checks for these circuits will be given later) and that a normal indication was obtained for the check at test point Ⓓ, the mixer-grid circuit may be checked by introducing a signal of known amplitude and proper frequency at test point Ⓔ.

After the trouble is localized to a single circuit, simple voltage and resistance measurements may be used to locate the cause of circuit failure.

LESSON PLAN No. 5

TIME ALLOTTED: ½ HR.

SUBJECT

Mixer circuit.

OBJECTIVE

To analyze the mixer circuit.

INTRODUCTION

The difficulties encountered in efficiently amplifying v-h-f radio signals indicate the need for changing the frequency of these signals to a lower, fixed value where efficient amplification is possible.

SUBJECT MATERIAL

1. Purpose of the circuit.
2. Circuit location on the block diagram and on the schematic.
3. Type of circuit and tube used.
4. Path of the signal through the circuit.
5. Purpose of the individual circuit components.
    a. Grid and plate-circuit tuning components.
    b. Grid-circuit components.
    c. Cathode-circuit components.
    d. Screen-grid-circuit components.
    e. Plate-circuit components.
    f. Filament-circuit components.
6. Use of test points Ⓔ and Ⓓ.

CONCLUSIONS

Changing the frequency of the incoming signal to a fixed, lower value makes possible greater amplification per stage, more uniform receiver sensitivity and selectivity over the entire tuning range, and a reduction in the number of variable-tuned circuits which would otherwise be required for satisfactory receiver operation. A receiver using only variable-tuned r-f amplifier circuits has a selectivity ratio of approximately 3 to 1 from one end of its operating band to the other, while a receiver which changes the incoming-signal frequency to a fixed value has nearly constant selectivity and sensitivity over its entire operating range.

ORAL QUIZ

1. What is the purpose of the mixer circuit?
2. Is the coupling between the r-f amplifier-plate coil and the mixer-grid coil critical? How is the coupling changed?
3. Is the coupling between the doubler-plate coil and the mixer-grid coil critical?
4. What is the frequency of the signal from the doubler circuit?
5. How is the difference-frequency signal obtained?
6. How does the receiver provide a high degree of image rejection?
7. How is the mixer-grid circuit tuned? The mixer plate circuit?
8. Why are all capacitor and resistor leads in the mixer circuit kept as short as possible?
9. How is the over-all operation of the mixer circuit checked when the doubler and oscillator circuits are operating normally?
10. What kind of a signal should be introduced into the mixer circuit at test point Ⓓ to check the operation of the mixer circuit?

EXPERIMENT No. 4

TIME ALLOTTED: 3 HR.

SUBJECT

R-f amplifier and mixer circuits.

OBJECTIVE

To become familiar with the normal test indications of the r-f amplifier and mixer circuits, and with the method of checking their operation.

EQUIPMENT REQUIRED

1 Radio Receiver BC-639-A.
1 Rectifier Unit RA-42-B.
1 Power-supply cable equipped with two Jones connector sockets.
1 R-f signal generator (same as used in Experiment No. 3.)
1 600-ohm two watt carbon resistor, or equivalent.
1 Multimeter (20,000-ohm-per-volt sensitivity).

INSTRUCTIONS

After removing the receiver from the dust cover, connect it to the power-supply unit, using the power-supply cable equipped with two Jones connector sockets. Insert the headset plug into the MONITOR jack on the receiver front panel. Connect the power-supply unit to the power source, and operate the POWER ON switch to ON. (Do not apply power to the receiver unless a load is connected across its output). Also connect the r-f signal generator to the power source, and operate its POWER switch to ON. Allow both the receiver and the signal generator to warm-up for several minutes before continuing with the procedure.

Do not change the positions of the operating controls on either the receiver or the test equipment unless directed to do so. Make only the tests outlined.

PROCEDURE

1. Set the operating controls on the r-f signal generator to the following positions:

Set POWER switch to ON.
Set MODULATION switch to INTERNAL.
Set generator output frequency to 145 mc.
Set r-f CARRIER to proper level.
Set MODULATION control to 30%.
Set r-f OUTPUT control to 500 microvolts.

2. Set the operating controls on the receiver to the following positions:

CONTROL	POSITION
ATTENUATION switch	0 DB
C. W. TONE CONTROL	Center line
R. F. GAIN INCREASE	Maximum clockwise
C. W. AND MANUAL-MANUAL-A. V. C. switch	MANUAL
AUDIO GAIN INCREASE	Maximum clockwise
Tuning control	To position where MEGACYCLES dial indicates 145 mc.

3. To determine whether the mixer circuit is operating, proceed as follows:

a. Connect the ungrounded output lead of the signal generator through a .1-uf. capacitor to pin 5 of the r-f amplifier tube (test point E); connect the grounded lead to the chassis.

b. A loud, clear tone should be heard in the headset.

4. To determine whether the r-f amplifier is operating, proceed as follows:

a. Connect the output lead of the signal generator to the antenna-input receptacle of the receiver (test point F).

b. A loud, clear tone should be heard in the headset.

NOTE: Since the test signal which is used in checking the r-f amplifier circuit also passes through the mixer circuit, it is obvious that this test may be used to check the operation of both circuits simultaneously.

5. To determine the amplification, or gain, of the r-f amplifier circuit, proceed as follows:

a. Connect the multimeter (30-volt a-c range) or an output meter in parallel with a 600-ohm, two-watt carbon resistor, or its equivalent, across terminals 11 and 12 of the receiver-power-supply plug 263.

b. Connect the output lead of the signal generator to the antenna-input receptacle of the receiver (key test point F).

c. Remove the headset plug from the MONITOR jack.

d. Adjust the setting of the OUTPUT control on the signal generator for a receiver-output indication of 5 volts.

e. Adjust the tuning control on the signal generator for maximum receiver-output indication.

f. Repeat step 5.d.; then record the microvolt setting of the OUTPUT control.

g. Disconnect the signal generator from test point F. Connect the ungrounded output lead through a .1-uf. capacitor to pin 5 of the r-f amplifier tube (test point E); connect the ground lead to the chassis.

h. Adjust the setting of the OUTPUT control on the signal generator for a receiver-output indication of 5 volts; then record the setting of the OUTPUT control.

i. Calculate the gain of the r-f amplifier circuit by dividing the OUTPUT control setting recorded in step 5.h. by that recorded in step 5.f.

6. To determine the effect that a change in the position of the R.F. GAIN INCREASE control has upon the gain of the r-f amplifier circuit, proceed as follows:

a. Adjust the setting of the OUTPUT control on the signal generator for a receiver-output indication of 10 volts. Record the setting of the OUTPUT control.

b. Adjust the R.F. GAIN INCREASE control counterclockwise until the receiver-output indication is 5 volts.

c. Disconnect the signal generator from test point E, and connect it to the antenna-input receptacle of the receiver (test point F).

d. Adjust the setting of the OUTPUT control on the signal generator for a receiver-output indication of 5 volts; then record the OUTPUT control setting.

e. Calculate the gain of the r-f amplifier circuit by dividing the OUTPUT control setting recorded in step 6.a. by that recorded in step 6.d.

f. Compare the gain of the r-f amplifier circuit obtained in step 5.i. with that obtained in step 6.e., and note the effect of the R.F. GAIN INCREASE control upon the gain of the r-f amplifier.

7. To determine the effect which the r-f amplifier circuit has upon the selectivity of the receiver, proceed as follows:

a. Set the R. F. GAIN INCREASE control on the receiver to its maximum (fully clockwise) position.

b. Adjust the setting of the output control on the signal generator for a receiver-output indication of 10 volts.

c. Adjust the tuning control on the receiver in a clockwise direction, until a receiver-output indication of 2.5 volts is obtained; then record the frequency indicated by the MEGACYCLES dial.

d. Readjust the tuning control on the receiver in a counterclockwise direction, past the point of peak receiver output, until an indication of 2.5 volts is again obtained. Again record the frequency indicated by the MEGACYCLES dial.

e. Calculate the receiver selectivity by subtracting the lowest frequency recorded in steps 7.c. and 7.d. from the highest.

f. Readjust the tuning control for peak receiver-output indication.

g. Disconnect the signal generator from test point F. Connect the ungrounded output lead through a .1-uf. capacitor to pin 5 of the r-f amplifier tube (test point E); connect the ground lead to the chassis.

h. Adjust the setting of the OUTPUT control on the signal generator for a receiver-output indication of 10 volts.

i. Readjust the tuning control for peak receiver-output indication.

j. Repeat step 7.h.

k. Adjust the tuning control on the receiver in a clockwise direction, until a receiver-output indication of 2.5 volts is obtained; then record the frequency indicated by the MEGACYCLES dial.

l. Readjust the tuning control in a counterclockwise direction, past the point of peak receiver output, until an indication of 2.5 volts is again obtained. Again record the frequency indicated by the MEGACYCLES dial.

m. Calculate the receiver selectivity by subtracting the lowest frequency recorded in steps 7.k. and 7.l. from the highest.

n. Compare the calculated receiver selectivity of step 7.e. with the calculated receiver selectivity of step 7.m., and note how much effect the r-f amplifier has upon the selectivity of the receiver.

8. To determine the effect of improperly tuned r-f and mixer circuits upon the sensitivity of the receiver, proceed as follows:

a. Disconnect the signal generator from test point Ⓔ, and connect it to the antenna-input receptacle (test point Ⓕ).

b. Adjust the setting of the OUTPUT control on the signal generator for a receiver-output indication of 5 volts.

c. Adjust the tuning control for peak receiver-output indication; then record the frequency indicated by the MEGACYCLES dial.

d. Adjust the setting of the OUTPUT control on the signal generator for a receiver-output indication of 5 volts; then record the setting of the OUTPUT control.

e. Detune the r-f and mixer tuned circuits by turning adjustment 204-1, located on the top front of the r-f assembly, three turns counterclockwise, and by turning adjustment 204-3, located on the top rear of the r-f assembly, one turn clockwise.

f. Repeat step 8.d.

g. Compare the OUTPUT control settings recorded in step 8.d. with those recorded in step 8.f., and note the effect of detuning upon the receiver sensitivity.

9. To determine the effect of improperly tuned r-f and mixer circuits upon the selectivity of the receiver, proceed as follows:

a. Adjust the setting of the OUTPUT control on the signal generator for a receiver-output indication of 10 volts.

b. Adjust the tuning control on the receiver in a clockwise direction, until a receiver-output indication of 2.5 volts is obtained; then record the frequency indicated by the MEGACYCLES dial.

c. Readjust the tuning control in a counterclockwise direction, past the point of peak receiver output, until an indication of 2.5 volts is again obtained. Again record the frequency indicated by the MEGACYCLES dial.

d. Calculate the selectivity of the receiver by subtracting the lowest frequency recorded in steps 9.b. and 9.c. from the highest.

e. Compare the receiver selectivity calculated in step 9.d. with that in step 7.e., and note the effect of detuning upon the receiver selectivity.

10. Restore the r-f and mixer tuned circuits to their original correctly tuned condition as follows:

a. Reset the tuning control on the receiver to the position where the MEGACYCLES dial reading is the same as that recorded in step 8.c. (145 megacycles).

b. Reset adjustments 204-1 and 204-3, which were detuned in step 8.e., to the positions where maximum receiver output is obtained.

11. Disconnect the signal generator from the receiver.

12. Using the multimeter as a d-c voltmeter, measure the voltages between the tube-socket terminals and the chassis. Record the voltage readings in the following chart:

R-F AMPLIFIER TUBE VT-203 (9003)

PIN No.	VOLTAGE	TUBE ELEMENT
1		
2		
5		
6		
7		

MIXER TUBE VT-203 (9003)

1		
2		
5		
6		
7		

13. Operate the POWER ON switch on the power-supply unit to off. Using the multimeter as an ohmmeter, measure and record the resistance between the chassis and the points indicated in the following chart:

R-F AMPLIFIER TUBE SOCKET

PIN No.	OPERATING CONTROL	POSITION	RESISTANCE IN OHMS	CIRCUIT COMPONENTS MEASURED
1	C. W. AND MANUAL-MANUAL-A. V. C.	MANUAL		
1	C. W. AND MANUAL-MANUAL-A. V. C.	A. V. C.		
5				
6				
7	R. F. GAIN INCREASE	Maximum (clockwise)		
7	C. W. AND MANUAL-MANUAL-A. V. C.	MANUAL		
7	R. F. GAIN INCREASE	Minimum (counterclockwise)		

MIXER TUBE SOCKET

PIN No.	OPERATING CONTROL	POSITION	RESISTANCE IN OHMS	CIRCUIT COMPONENTS MEASURED
1				
5				
6				
7				

14. After completing the preceding portion of the experiment, request the instructor to place trouble in the r-f amplifier or mixer circuit of the receiver. Using the tests given in the preceding portion of the experiment, locate and correct the trouble.

CONCLUSIONS

1. Why is less signal required at test point Ⓕ than at test point Ⓔ to produce the same output-meter indication?
2. How much gain does the r-f amplifier circuit provide?
3. What effect does the R.F. GAIN INCREASE control have upon the gain of the r-f amplifier circuit?
4. Is a receiver which uses an r-f amplifier circuit more selective than one which does not use such a circuit?
5. What effect do improperly tuned r-f and mixer circuits have upon the operation of the receiver?
6. What value of voltage is normally present on pin 5 of the r-f amplifier tube? On pin 6?
7. Approximately what value of voltage would be measured at pin 6 of the r-f amplifier tube if resistor 209 were open?
8. With the C.W. AND MANUAL-MANUAL-A.V.C. switch in the A.V.C. position, what value of resistance would be measured between the plate (pin 5) of the r-f amplifier tube and the chassis if capacitor 205-4 were shorted?

LECTURE No. 6

CIRCUIT ANALYSIS OF HIGH-FREQUENCY OSCILLATOR

The high-frequency oscillator circuit in Radio Receiver BC-639-A is used in conjunction with a frequency-doubler circuit to provide a signal voltage of the proper frequency to the mixer circuit, for use in the frequency-conversion process. The h-f-oscillator circuit is a part of the oscillator assembly (see figures 9 and 17), and is shown in block form in figure 15 and in schematic form in figure 18. This circuit uses a high-frequency triode, type VT-202 (9002), in a modified type of Hartley oscillator circuit.

As in other oscillator circuits of this type, high-frequency oscillations are generated by feeding back a sufficient amount of energy in proper phase from the plate circuit to the grid circuit.

As shown in figure 18, the plate of the oscillator tube is connected to the low end of oscillator coil 223, and the grid to the high end. The tap near the center of the coil is effectively connected to ground through the 150-uuf. capacitor, 225. The oscillator coil may be considered as being divided into two parts, with one part serving as the plate load for the oscillator tube, and the other part as the grid load. A voltage appearing across the plate-load portion of the coil induces a voltage of opposite phase into the grid portion of the coil by means of inductive coupling between the two parts of the coil. This voltage is applied to the grid of the oscillator tube, through the .001-uf. oscillator-grid capacitor, 276-1; thus the conditions necessary for generating oscillations are satisfied.

The oscillations that are generated are introduced into the doubler circuit through a 27-uuf. coupling capacitor, 224, which is connected between the plate of the oscillator tube and the grid of the doubler tube. The frequency of these oscillations depends upon the tuning of the oscillator coil, 223. This coil is tuned over a range of 44 to 72 megacycles by means of variable capacitor 218B, which in conjunction with variable capacitor 218A (used in tuning the doubler circuit) forms a two-gang tuning capacitor with an ungrounded rotor. This capacitor is mechanically coupled to the main tuning dial. A concentric-type trimmer capacitor, 204-5, which is connected in parallel with variable tuning capacitor 218B, and the adjustable copper-slug core in oscillator coil 223 are both used to establish proper tracking of the h-f oscillator circuit with the doubler, mixer and r-f amplifier circuits.

The .001-uf. grid-circuit capacitor, 276-1, not only provides a path to the grid for the oscillatory voltage developed across oscillator coil 223, but also prevents the d-c voltage on the coil from being applied to this element of the oscillator tube. This capacitor is also used in conjunction with the 47,000-ohm grid resistor, 226, to provide the oscillator tube with the necessary operating bias. This bias is solely the result of grid

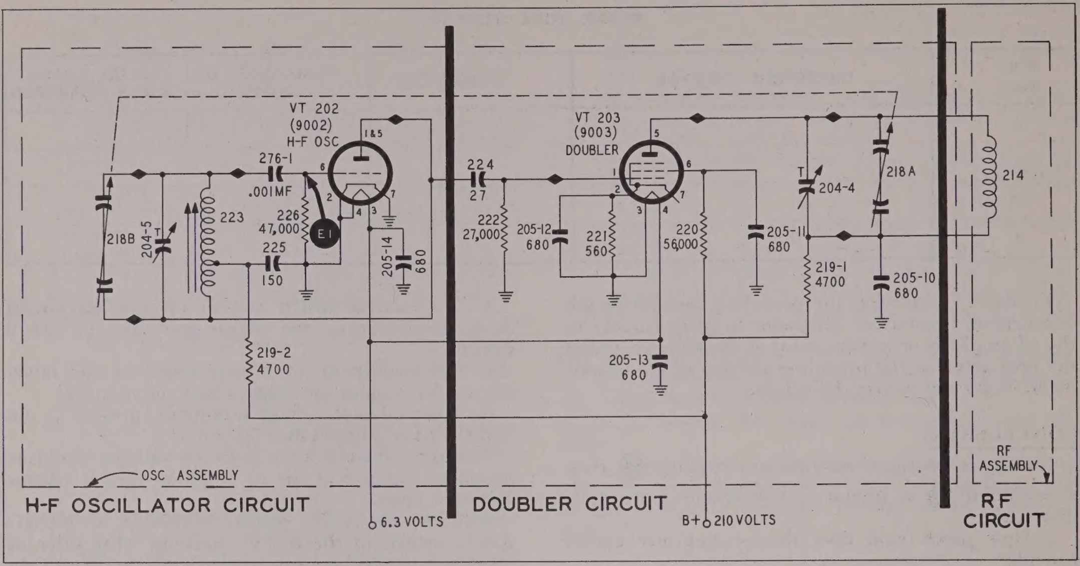


Figure 18. Schematic Diagram of H-F-Oscillator and Doubler Circuits

rectification of the oscillator signal, since no other source of grid bias is provided and since the cathode is connected directly to ground. The plate voltage for the tube is obtained from the high-voltage bus, through a 4700-ohm plate-filter resistor, 219-2, and through the lower half of oscillator coil 223, which serves as the plate load for the tube. A 150-uuf. oscillator-plate by-pass capacitor, 225, which is connected between the center terminal of the oscillator coil and ground, completes both the grid and plate circuits of the oscillator tube, and in conjunction with the 4700-ohm plate-filter resistor also keeps the oscillator signal out of the power supply. The ungrounded side of the tube filament is kept at r-f ground potential by the 680-uuf. filament by-pass capacitor, 205-14, which is connected between the filament terminal and ground.

Failure of any component in the h-f oscillator circuit affects the over-all operation of the receiver. The best check of the operation of this circuit is to measure both the frequency and amplitude of the signal generated by the circuit. However due to the difficulty of making such measurements, a voltage check at test point E1 is generally used to determine whether the oscillator is operating. This check, when made correctly, indicates the relative amplitude of the generated signal, but it does not give any indication of whether the frequency of the signal is correct. An indication of the correctness of the frequency is obtained when the operation of both the doubler and mixer circuits is checked at test point E.

LESSON PLAN No. 6

TIME ALLOTTED: 1/3 HR.

SUBJECT

High-frequency oscillator circuit.

OBJECTIVE

To analyze the h-f oscillator circuit.

INTRODUCTION

The oscillator circuit in a receiver should be capable of furnishing a stable r-f voltage of sufficient strength and of the proper frequency to the mixer circuit, to enable the mixer to operate efficiently at all frequencies within the range of the receiver.

SUBJECT MATERIAL

1. Purpose of the circuit.
2. Circuit location on the block diagram and schematic.
3. Type of circuit and tube used.
4. How the signal is generated.
5. Circuit tuning.
6. Purpose of the individual circuit components.
   a. Grid-circuit components.
   b. Plate-circuit components.
   c. Filament-circuit components.
7. Use of test points E1 and F.

CONCLUSIONS

Since the h-f oscillator circuit used in the BC-639-A operates in conjunction with a frequency doubler, any error or shift in the oscillator frequency is magnified by the doubling action. It is extremely important, therefore, that the frequency stability of the h-f oscillator be exceptionally good. Since the operating frequency of the oscillator is not as high nor its output as great as would normally be required if the doubler circuit were not used, the drain upon the r-f power of the circuit is low. This factor and the use of a low LC ratio (high C) in the oscillator tuned circuit make the stability of the oscillator circuit used in the BC-639-A inherently good.

ORAL QUIZ

1. Where in the receiver is the h-f oscillator circuit located?
2. Is the signal generated by the h-f oscillator of the required frequency value for direct use in the mixer-circuit conversion process?
3. What is the frequency range of the h-f oscillator? How is the frequency controlled?
4. How is the oscillator signal introduced into the doubler circuit?
5. What means are provided for establishing proper tracking of the h-f oscillator circuit with the doubler, mixer, and r-f amplifier circuits?
6. How does the oscillator tube obtain its operating bias?
7. What is the purpose of the capacitor connected between the center terminal of the oscillator coil and ground?
8. How is the operation of the h-f oscillator circuit generally checked?

LECTURE No. 7

CIRCUIT ANALYSIS OF DOUBLER

The doubler circuit used in the BC-639-A multiplies the frequency of the signal generated by the h-f oscillator. It is used in conjunction with the h-f oscillator in supplying the mixer circuit with the local signal required for the conversion process. The doubler circuit is a part of the oscillator assembly (figures 9 and 17), and is shown in block form in figure 15 and in schematic form in figure 18. This circuit, as shown on the schematic, uses a supercontrol r-f pentode tube, type VT-203 (9003).

When a signal voltage from the h-f oscillator circuit is introduced into the untuned grid circuit of the doubler tube through the 27-uuf. coupling capacitor 224, the doubler tube operating as a nonlinear amplifier produces a number of different signals, including harmonics of the oscillator signal. These harmonics are present in the plate circuit of the tube along with the amplified oscillator signal. The use of coil 214 as the plate load of the doubler tube enables the circuit to select the 2nd-harmonic signal and reject all of the others, since this coil is tuned to twice the oscillator-signal frequency and, hence, appears as a relatively low impedance to all signal frequencies except the 2nd-harmonic frequency. Therefore, the highest voltage is developed at the 2nd-harmonic frequency, and all voltages resulting from the other signal frequencies are of comparatively low magnitude. Inductive coupling between the doubler-tube plate coil, 214, and the mixer-grid coil, 213, is used to introduce the 2nd-harmonic signal of the oscillator into the mixer circuit.

The doubler-circuit plate coil, 214, is tuned over a range of 88 to 144 megacycles by means of variable capacitor 218A. A concentric-type trimmer capacitor, 204-4, is connected in parallel with tuning capacitor 218A for use in compensating for slight errors in circuit tracking. Variable capacitor 218A and variable capacitor 218B, which is used in tuning the oscillator circuit, form a two-gang tuning capacitor with an ungrounded rotor. This two-gang tuning capacitor is mechanically coupled to the tuning dial together with the three-gang tuning capacitor used to tune both the r-f amplifier and mixer circuits. Thus while the three-gang tuning capacitor is tuning the signal-frequency circuits from 100 to 156 mc., the two-gang tuning capacitor is tuning the doubler circuit from 88 to 144 mc. and the h-f oscillator from 44 to 72 mc.

The 27-uuf. coupling capacitor, 224, not only provides a path for the oscillator signal but also prevents the d-c voltage on the plate of the oscillator tube from being applied to the grid of the doubler tube. This capacitor in conjunction with the 27,000-ohm grid resistor, 222, is used in providing the doubler tube with the bias voltage which results from grid rectification of the oscillator signal. The 27,000-ohm grid resistor, 222, also provides the grid of the doubler tube with a d-c return path to ground. In addition a fixed operating bias for the tube is provided by the 560 ohm resistor, 221, in the cathode circuit. The cathode and suppressor grid are connected together, and are kept at r-f ground potential by means of the 680-uuf. cathode by-pass capacitor 205-12. The screen-grid voltage is obtained from the main high-voltage bus, through the 56,000-ohm resistor, 220. The screen grid is kept at r-f ground potential by the 680-uuf. screen by-pass capacitor, 205-11. Operating voltage for the plate is also obtained from the main high-voltage bus, through the 4700-obm plate-filter resistor, 219-1, and the doubler-plate coil, 214. The low end of the doubler-plate coil is kept at r-f ground potential by the 680-uuf. doubler-plate by-pass capacitor, 205-10. The ungrounded side of the tube filament is kept at r-f ground potential by the 680-uuf. by-pass capacitor, 205-13. All of the resistor leads and by-pass-capacitor leads are kept as short as possible, to minimize radiation and to improve the efficiency of the circuit.

Failure of any component within this circuit affects the over-all operation of the receiver. Failure of the circuit to deliver a signal of the proper frequency to the mixer circuit results in complete failure of the equipment, since the proper operation of the mixer circuit depends upon the reception of signals of the proper frequency from both the doubler circuit and r-f amplifier circuit. The operation of the doubler circuit may be checked by introducing a signal of the proper frequency and of known amplitude into its untuned grid circuit and measuring both the frequency and amplitude of the resulting signal voltage across the doubler-tube tuned-plate coil, 214. However, due to the difficulty of making such measurements, the output of the over-all receiver is generally used for indicating the condition of the doubler circuit, after it has been determined first that the h-f oscillator circuit and all of the circuits located between the r-f amplifier circuit and the output of the receiver are in good condition. Under these conditions, the operation of the doubler circuit is checked by introducing a signal of the proper frequency and amplitude into the mixer circuit at test point Ⓔ and observing the receiver output indication. A specific output indication will be obtained only when the doubler circuit is operating normally. Failure to obtain this indication points to trouble in the circuit, since both the h-f oscillator and mixer circuits are assumed to be operating normally. Simple voltage and resistance measurements are then used to locate the cause of circuit failure.

The tests outlined in the previous lectures on the mixer circuit and the h-f oscillator circuit are used to determine whether those circuits are operating normally.

LESSON PLAN No. 7

TIME ALLOTTED: 1/3 HR.

SUBJECT

Doubler circuit.

OBJECTIVE

To analyze the doubler circuit.

INTRODUCTION

Due to the difficulty of constructing an h-f oscillator which will operate over a wide range of very high frequencies and still maintain the required frequency stability, frequency multipliers are often used. Since both frequency and range are multiplied by a frequency multiplier, frequency multiplication makes it possible in covering a specific band of frequencies, to use an oscillator that operates at a lower frequency and over a smaller range where the problems of frequency are more easily overcome. A frequency multiplier is used in the BC-639-A.

SUBJECT MATERIAL

1. Purpose of the circuit.
2. Circuit location on the block diagram and on the schematic.
3. Tube used.
4. How the circuit operates.
5. Purpose of the individual circuit components.
    a. Plate-circuit tuning components.
    b. Grid-circuit components.
    c. Cathode-circuit components.
    d. Screen-grid-circuit components.
    e. Plate-circuit components.
    f. Filament-circuit components.
6. Effect of circuit failure and ways of checking the circuit. Use of test point Ⓔ .

CONCLUSIONS

The production of the 12-mc. i-f signal depends largely upon the mixer circuit's receiving the correct signal frequency from the doubler circuit. The doubler circuit will, under normal conditions, accomplish its purpose if it receives the correct signal frequency from the h-f oscillator circuit, and if its plate circuit is tuned to twice the frequency of the oscillator signal.

ORAL QUIZ

1. Where in the receiver is the doubler circuit located?
2. What characteristics of the doubler circuit causes frequency doubling?
3. What circuits are tuned by the two-gang tuning capacitor which is coupled to the main tuning dial? What circuits are tuned by the three-gang tuning capacitor?
4. What is the purpose of the 27,000-ohm grid resistor 222?
5. Will the receiver operate normally if the plate circuit of the doubler tube is tuned to three times the frequency of the oscillator signal?
6. To what harmonic of the oscillator signal must the plate circuit of the doubler tube be tuned in order to provide normal receiver operation?
7. How is the operation of the doubler circuit checked?

EXPERIMENT No. 5

TIME ALLOTTED: 2 HR.

SUBJECT

H-f oscillator and doubler circuits.

OBJECTIVE

To become familiar with the normal test indications of the h-f oscillator and doubler circuits, and with the method of checking their operation.

EQUIPMENT REQUIRED

1 Radio Receiver BC-639-A.
1 Rectifier Unit RA-42-B.

1 Power-supply cable equipped with two Jones connector sockets.
1 Multimeter (20,000-ohms-per-volt sensitivity).
1 R-f signal generator (same as used in Experiment No. 3.)
1 R-f isolating choke.
1 600-ohms, two-watt carbon resistor or equivalent.
1 Head set.

INSTRUCTIONS

After removing the receiver from the dust cover, connect it to the power-supply unit, using the power-supply cable equipped with the two Jones connector sockets. Insert the headset plug into the MONITOR jack on the receiver front panel. Connect the power-supply unit to the power source, and operate the POWER ON switch to ON. (Do not apply power to the receiver unless a load is connected across its output.) Also connect the r-f signal generator to the power source, and operate the POWER switch to ON. Allow both the receiver and the signal generator to warm up for several minutes before continuing with the procedure.

Do not change the positions of the operating controls on either the receiver or the test equipment unless directed to do so. Make only the tests outlined.

PROCEDURE

1. Set the operating controls on the r-f signal generator to the following positions:

Set POWER switch to ON.
Set MODULATION switch to INTERNAL.
Set generator output frequency to 145 mc.
Set r-f CARRIER to proper level.
Set MODULATION control to 30%.
Set r-f OUTPUT control to 500 microvolts.

2. Set the operating controls on the receiver to the following positions:

CONTROL	POSITION
ATTENUATION switch	0 DB
R. F. GAIN INCREASE	Fully clockwise
C. W. AND MANUAL-MANUAL-A. V. C. switch	MANUAL
AUDIO GAIN INCREASE	Fully clockwise

3. To determine whether the h-f oscillator is operating, proceed as follows:

a. Using the multimeter as a d-c voltmeter (30-volt range), connect the negative lead, in series with an r-f isolating choke or resistor (100,000 ohms or greater), to pin 6 of the h-f oscillator tube, VT-202 (9002), test point E1 ; connect the positive lead to the receiver chassis.

b. Tune the receiver through its entire tuning range while observing the multimeter indication.

c. The multimeter should indicate 5 volts, or more, over the entire tuning range.

d. Disconnect the multimeter from test point D1.

4. To determine whether the doubler circuit is operating, when it is known that the h-f oscillator is operating, proceed as follows:

a. Adjust the receiver tuning control to the position where the MEGACYCLES dial indicates 145 mc.

b. Connect the ungrounded output lead of the signal generator through a .1-uf. capacitor to pin 5 of the r-f amplifier tube (test point E); connect the grounded lead to the receiver chassis.

c. A loud, clear tone should be heard in the headset.

NOTE: Since the h-f oscillator signal passes through the doubler circuit, it is obvious that a check of the operation of the doubler is also a check of the operation of the h-f oscillator circuit.

5. To determine the effect of improper tuning of the h-f oscillator circuit upon both the receiver sensitivity and the accuracy of the MEGACYCLES dial calibration, proceed as follows:

a. Disconnect the signal generator from test point A , and connect it to the antenna-input receptacle of the receiver (test point F).

b. Connect the multimeter (30-volt a-c range) or an output meter in parallel with the 600-ohm, two-watt, carbon resistor or its equivalent across terminals 11 and 12 of the receiver power-supply plug 263.

c. Remove the headset plug from the MONITOR jack on the receiver front panel.

d. Adjust the setting of the OUTPUT control on the signal generator for receiver-output indication of 5 volts.

e. Adjust the tuning control on the receiver for maximum receiver-output indication.

f. Repeat step 5.d., and then record the setting of the OUTPUT control.

g. Record both the frequency indicated on the signal-generator dial, and the frequency indicated on the receiver MEGACYCLES dial.

h. Compare the frequency indication of the signal generator with that of the receiver.

NOTE: When an accurately calibrated signal generator is used, and when the receiver is properly tuned, the frequency indications recorded in step 5.g. will be the same.

i. Adjust the OUTPUT control on the signal generator for a receiver output indication of 10 volts.

j. Detune the h-f oscillator circuit by turning adjustment 204-5 (located directly beneath h-f oscillator coil 223 on the top front of the oscillator assembly) in a counterclockwise direction for a receiver output indication of 2.5 volts.

k. Adjust the tuning control on the receiver for maximum receiver output.

l. Compare the frequency indication on the receiver MEGACYCLES dial with that recorded in step 5.g., and note the effect of detuning upon dial calibration.

m. Adjust the setting of the OUTPUT control on the signal generator for a receiver-output indication of 5 volts; then record the OUTPUT control setting.

n. Compare the OUTPUT control setting recorded in step 5.m. with that recorded in step

5.f., note the effect of detuning upon the sensitivity of the receiver.

6. Restore the h-f oscillator circuit to its original correctly tuned condition as follows:

a. Reset the tuning control on the receiver to the position where the MEGACYCLES dial reading is the same as that recorded in step 5.g.

b. Reset adjustment 204-5, which was detuned in step 5.j., to the position where maximum receiver output is obtained.

c. Adjust the OUTPUT control on the signal generator for a receiver-output indication of 5 volts, and repeat step 6.b.

7. To determine the effect of improper tuning of the doubler circuit upon both the receiver sensitivity and the accuracy of the MEGACYCLES dial calibration, proceed as follows:

a. Adjust the OUTPUT control on the signal generator for a receiver-output indication of 5 volts; then record the OUTPUT control setting.

b. Adjust the OUTPUT control on the signal generator for a receiver-output indication of 10 volts.

c. Detune the doubler circuit by turning adjustment 204-4 (located on the top rear of the oscillator assembly) counterclockwise for a receiver-output indication of 2.5 volts.

d. Adjust the tuning control on the receiver for maximum receiver output.

e. Adjust the OUTPUT control on the signal generator for a receiver-output indication of 5 volts; then record the OUTPUT control setting.

f. Compare the OUTPUT control setting recorded in step 7.a. with that recorded in step 7.e. Note the effect of detuning upon the sensitivity of the receiver.

g. Compare the frequency indicated on the MEGACYCLES dial of the receiver with that recorded in step 5.g. Note the effect of detuning upon dial calibration.

8. Restore the doubler circuit to its original correctly tuned condition as follows:

a. Reset the tuning control on the receiver to the position where the MEGACYCLES dial indication is the same as that recorded in step 5.g.

b. Reset adjustment 204-4, which was detuned in step 7.c., to the position where maximum receiver-output indication is obtained.

c. Adjust the OUTPUT control on the signal generator for a receiver-output indication of 5 volts; then repeat step 8.b.

9. Disconnect the signal generator from the receiver.

10. Using the multimeter as a voltmeter, measure the voltages between the tube-socket terminals and chassis. Record the voltage readings in the following chart.

H-F OSCILLATOR TUBE SOCKET

PIN No.	VOLTAGE	TUBE ELEMENT
1		
2		
5		
6		

DOUBLER TUBE SOCKET

PIN No.	VOLTAGE	TUBE ELEMENT
1		
2		
5		
6		
7		

11. Operate the POWER ON switch on the power supply to off. Using the multimeter as an ohmmeter, measure the resistance between the chassis and the socket terminals indicated in the following chart.

H-F OSCILLATOR TUBE SOCKET

PIN No.	RESISTANCE	COMPONENTS MEASURED
1		
2		
6		

DOUBLER TUBE SOCKET

1		
2		
5		
6		

12. After completing this portion of the experiment, request the instructor to put trouble into the h-f oscillator and doubler circuits. Using the tests given in the preceding portion of this experiment, locate and correct the trouble.

CONCLUSIONS

1. Why is it considered good practice to allow both the signal generator and the receiver to warm up for several minutes before being used?

2. Why does the presence of a d-c voltage at test point E1 (h-f oscillator grid) indicate that the oscillator is operating?

3. How is the operation of the doubler circuit checked?

4. Upon what factor does the accuracy of the MEGACYCLES dial calibration principally depend?

5. Is the receiver sensitivity affected by improper tuning of the h-f oscillator circuit?

6. Is the receiver sensitivity affected by improper tuning of the doubler circuit?

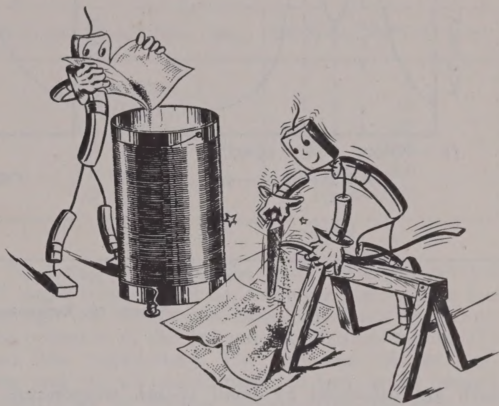
7. What would be the effect upon the receiver output if no screen voltage were present at pin 6 of the doubler tube?

8. If capacitor 205-10 were shorted, what voltage would be measured at pin 5 of the doubler tube? If resistor 219-1 became open?

9. How would the defective part be located?

LECTURE No. 8

CIRCUIT ANALYSIS OF I-F AMPLIFIER

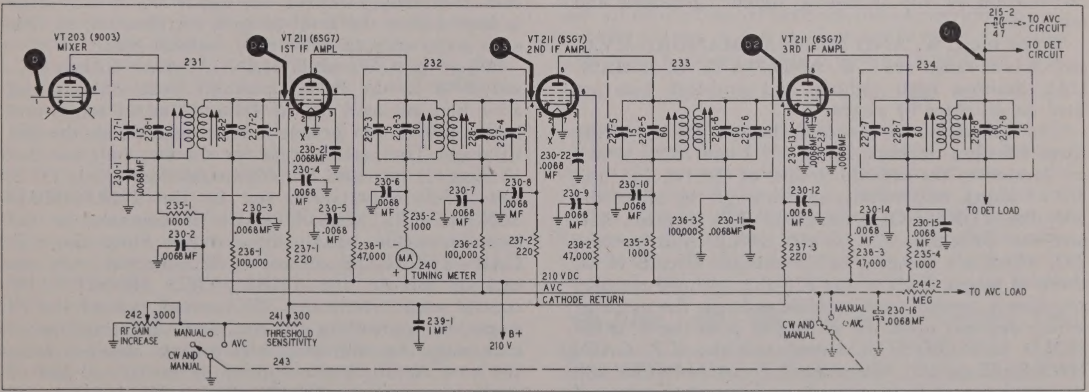


The i-f amplifier circuit in the BC-639-A is used to amplify the 12-mc. difference-frequency (i-f) signal provided by the mixer circuit. It is located along the rear of the receiver chassis (see figures 9 and 21), and is shown in block form in figure 15 and in schematic form in figure 19. The i-f amplifier circuit is a three-stage tuned amplifier which utilizes four i-f transformers. Each i-f stage uses a remote cut-off pentode tube, type VT-211 (6SG7), and a separate i-f transformer.

The signal produced by the conversion process in the mixer circuit is present in the tuned primary of the 1st i-f transformer, 231. Inductive coupling between the tuned primary and the tuned secondary of this transformer is used to introduce the signal into the grid circuit of the 1st i-f stage. Amplification of the signal in this stage and in each of the succeeding i-f amplifier stages results in a fairly high signal voltage being delivered to the detector circuit for demodulation, and to the a-v-c circuit for automatic-volume-control purposes. Inductive coupling between the tuned primary and the tuned secondary of each of the i-f transformers, 232, 233, and 234, is used to introduce the signal into the grid circuit of the 2nd and 3rd i-f amplifiers and into the diode circuits of the detector-a.v.c.-1st a-f-amplifier tube, respectively.

The i-f amplifier circuit operates at a frequency of 12 mc. and is designed to provide a 10-milliwatt receiver output when a 15-microvolt signal is introduced into the circuit at the mixer-tube grid. This circuit has a bandwidth of 140 kc. as measured at points 6 db down from the maximum response point. The bandwidth is primarily the result of overcoupling in both the 1st and 2nd i-f transformers, since the overcoupling provides a double-humped frequency-response curve similar to that shown in figure 20a, with peaks occurring 70 kc. each side of the 12-mc. point. Upon combining the frequency-response characteristics of these two i-f transformers with the frequency-response characteristics of the 3rd and 4th i-f transformers, which are not overcoupled and which have a normal response as shown in figure 20b, a fairly uniform bandpass response curve 140 kilocycles wide is obtained, as shown in figure 20c. The i-f amplifier provides good selectivity and a bandpass sufficiently wide for the receiver to remain in tune despite small variations that may occur in signal frequency or in the h-f oscillator circuit.

The primary and secondary coils of each of the four i-f transformers used in the circuit are tuned to approximately 12 mc. by special h-f 60-uuf. fixed capacitors


VT 203 (9003)
MIXER
D
D4
VT 211 (6SG7)
1ST IF AMPL
D3
VT 211 (6SG7)
2ND IF AMPL
D2
VT 211 (6SG7)
3RD IF AMPL
D1
231
232
233
234
227-1 15
228-1 60
228-2 60
227-2 15
227-3 15
228-3 60
228-4 60
227-4 15
227-5 15
228-5 60
228-6 60
227-6 15
227-7 15
228-7 60
228-8 60
227-8 15
230-1 .0068MF
235-1 1000
230-2 .0068 MF
230-3 .0068MF
236-1 100,000
230-21 .0068MF
230-4 .0068 MF
230-5 .0068 MF
237-1 220
238-1 47,000
230-6 .0068 MF
235-2 1000
MA
240 TUNING METER
230-7 .0068 MF
236-2 100,000
230-8 .0068 MF
237-2 220
230-22 .0068 MF
230-9 .0068 MF
238-2 47,000
230-10 .0068 MF
235-3 1000
236-3 100,000
230-11 .0068MF
230-13 .0068MF
230-23 .0068MF
230-12 .0068 MF
237-3 220
230-14 .0068 MF
238-3 47,000
230-15 .0068 MF
235-4 1000
215-2 47
TO AVC CIRCUIT
TO DET CIRCUIT
TO DET LOAD
244-2 1 MEG
TO AVC LOAD
230-16 .0068MF
210 VDC
AVC
CATHODE RETURN
242 3000
RF GAIN INCREASE
MANUAL
AVC
CW AND MANUAL
241 300
THRESHOLD SENSITIVITY
239-1 1 MF
B+ 210 V
243
MANUAL
AVC
CW AND MANUAL

TP9-1322

Figure 19. Schematic Diagram of I-F-Amplifier Circuit

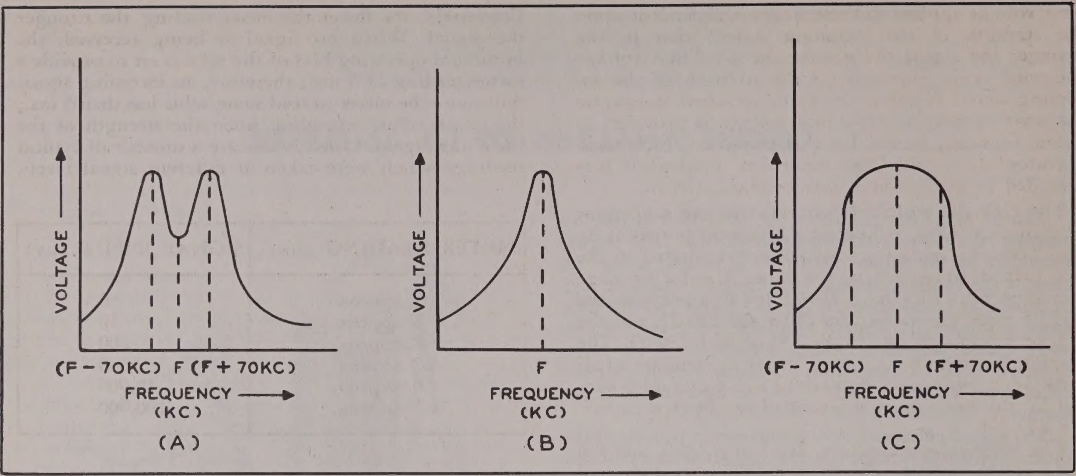


Figure 20. Response Curves of I-F Transformers

which are paralleled by small 15-uuf. temperature-compensating capacitors. The small capacitors keep the i-f transformers properly tuned when the receiver is subject to temperature variations. Exact tuning is accomplished by adjustment of the special powdered-iron cores in the coils themselves. The 1st i-f transformer is typical of the i-f transformers used. On the schematic diagram in figure 19, it can be seen that the primary and secondary of this transformer are paralleled by the fixed 60-uuf. capacitors 228-1 and 228-2, and by the 15-uuf. temperature-compensating capacitors 227-1 and 227-2, respectively, and that the special powdered-iron cores 229-1 and 229-2 tune the primary and secondary, respectively.

Operating bias for the i-f amplifier stages is obtained in two different ways:

1. By utilizing the voltage drop across the resistors in the cathode circuits (cathode bias).

2. By utilizing the voltage which is produced by rectification of the incoming signal (grid-leak and a-v-c bias).

When the C.W. AND MANUAL-MANUAL-A.V.C. switch is in either the C.W. AND MANUAL or MANUAL position both cathode and grid-leak bias are used on all three i-f stages.

The cathode bias is obtained through the use of the three 220-ohm resistors, 237-1, 237-2 and 237-3, which are located in the cathode circuits of the 1st, 2nd, and 3rd i-f stages, respectively, and through the use of the 300-ohm THRESHOLD SENSITIVITY control, 241, and the 3000-ohm R.F. GAIN INCREASE control, 242, which are common to the cathode circuits of all three i-f stages. Each of the 220-ohm cathode resistors provides a certain fixed cathode voltage, the value of which depends upon the setting of both the THRESHOLD SENSITIVITY control and the R.F. GAIN INCREASE control. When the R.F. GAIN INCREASE control is set at its maximum position, the setting of the THRESHOLD SENSITIVITY control determines the over-all gain of the i-f amplifiers, since it controls the cathode (operating) bias for all of the i-f stages. When the THRESHOLD SENSITIVITY control is once set, it seldom needs additional adjustment (except to compensate for sensitivity loss due to tube life), since the R.F. GAIN INCREASE control, which also determines the operating bias of all of the i-f stages, is used manually to control the gain of these stages.

The 100,000-ohm resistors, 236-1, 236-2, and 236-3, which are connected to the low end of the secondaries of the 1st, 2nd and 3rd i-f stages, respectively, provide the grid circuits of these stages with a high-resistance d-c path to ground, while the associated .0068-uf. capacitors, 230-3, 230-7, and 230-11, maintain the low ends of these secondaries at r-f ground potential. The 100,000-ohm resistor in the grid circuit of each stage and its associated .0068-uf. capacitor also form a grid-leak arrangement, which provides the stage with an additional bias voltage when the strength of the incoming signal is great enough to cause grid rectification. Normally, however, the signal fed to each stage is kept below the level of grid rectification, so that each stage operates with only cathode bias.

When the C.W. AND MANUAL-MANUAL-A.V.C. switch is in the A.V.C. position, both cathode and a-v-c bias are used on the 1st and 2nd i-f stages and both cathode and grid-leak bias are used on the 3rd i-f stage. The cathode bias for the 1st, 2nd, and 3rd i-f stages is provided by cathode resistors 237-1, 237-2, and 237-3, respectively, and by the THRESHOLD SENSITIVITY control, which is common to the cathode circuits of all three stages. Since the R.F. GAIN INCREASE control is disconnected from the cathode circuit, the THRESHOLD SENSITIVITY control alone determines the over-all gain of the i-f stages, by controlling the minimum operating bias of each stage. An additional bias voltage, obtained from the a-v-c circuit, is also applied to the 1st and 2nd i-f stages through the 100,000-ohm resistors, 236-1 and 236-2, when the strength of the incoming signal is above a certain specific value. The magnitude of the a-v-c voltage applied to these stages is dependent upon the strength of the incoming signal; that is, the stronger the signal the greater the a-v-c bias voltage and vice versa. However, if the strength of the incoming signal is below the value required to operate the a-v-c circuit, no a-v-c bias voltage is provided to either i-f stage; hence, for this condition, each stage operates with only the minimum (cathode) bias provided by the resistors in its cathode circuit.

The cathode, which is connected to the suppressor grid in each tube, is kept at r-f ground potential by two .0068-uuf. capacitors, which are connected to the two cathode terminals of the tube. The 1st i-f stage uses capacitors 230-4 and 230-21 for this purpose, the 2nd i-f stage uses capacitors 230-8 and 230-22, and the 3rd i-f stage uses capacitors 230-12 and 230-23. The portion of the cathode circuit which is common to all three i-f stages is also maintained at r-f ground potential by the 1-uf. sensitivity-control-bus by-pass capacitor, 239-1.

The 100,000-ohm resistors, 236-1 and 236-2, and the .0068-uf. capacitors, 230-3 and 230-7, in the grid circuits of the 1st and 2nd i-f stages, respectively, act as a filter for the a-v-c voltage applied to the stage. In addition to this function, capacitors 230-3 and 230-7 also maintain the low ends of the secondaries of the 1st and 2nd i-f transformers, respectively, at r-f ground potential. The function of the 100,000-ohm resistor, 236-3, and the .0068-uf. capacitor, 230-11, located in the grid circuit of the 3rd i-f stage, remains the same as when the C.W. AND MANUAL-MANUAL-A.V.C. switch was in the C.W. AND MANUAL or MANUAL position, since no a-v-c bias voltage is applied to this stage. The level of the signal fed to this stage is kept below the value which causes grid rectification, by the a-v-c bias voltage which is applied to the 1st and 2nd i-f stages and to r-f amplifier. Therefore, the only bias on the 3rd i-f stage is that which is provided by the resistors in its cathode circuit. The a-v-c voltage is used instead of the R.F. GAIN INCREASE control for controlling the gain of the i-f amplifier circuit, since the R.F. GAIN INCREASE control is disconnected from the circuit.

The screen-grid operating voltage for the 1st, 2nd, and 3rd i-f stages is obtained from the main high-voltage bus, through the 47,000-ohm screen dropping resistors, 238-1, 238-2, and 238-3, respectively. The screen grid of the 1st i-f stage is kept at r-f ground potential by the .0068-uf. screen by-pass capacitor, 230-5; the 2nd i-f stage, by the .0068-uf. screen by-pass capacitor, 230-9; and the 3rd i-f stage, by the .0068-uf. screen by-pass capacitor, 230-14.

Operating voltage for the plate of the 1st i-f stage is obtained from the main high-voltage bus, through the 0-10-ma. TUNING METER, 240, the 1000-ohm plate-filter resistor, 235-2, and the primary of the 2nd i-f transformer, 232. The TUNING METER is used to indicate the plate current of this stage, and its reading varies inversely with the bias voltage applied to the tube. When the C.W. AND MANUAL-MANUAL-A.V.C. switch is in the A.V.C. position and the a.v.c. is operating, this meter indicates the strength of the incoming signal, since the a-v-c bias voltage applied to the tube is dependent upon the strength of the incoming signal. The stronger the signal, the greater the a-v-c bias voltage applied to the tube, the smaller its plate current, and hence the smaller the meter reading. Conversely, the lower the meter reading, the stronger the signal. When no signal is being received, the minimum operating bias of the tube is set to provide a meter reading of 5 ma.; therefore, an incoming signal will cause the meter to read some value less than 5 ma.; the exact value depending upon the strength of the incoming signal. Listed below are a number of typical readings which were taken at different signal levels.

METER READING (ma.)	SIGNAL INPUT (uv)
5 approx.	0
5 approx.	10
4.8 approx.	100
3.2 approx.	1000
2.0 approx.	10,000
1.2 approx.	100,000

Operating voltage for the plate of the 2nd and 3rd i-f stages is obtained from the main high-voltage bus through the 1000-ohm resistors, 235-3 and 235-4, and the primaries of the 3rd and 4th i-f transformers, 233 and 234, respectively. The low ends of the 2nd, 3rd, and 4th i-f transformers are kept at r-f ground potential by the .0068-uf. plate by-pass capacitors 230-6, 230-10, and 230-15 respectively. The ungrounded side of the filament of the 3rd i-f stage is also kept at r-f ground potential by the .0068-uf. capacitor, 230-13, which is connected between the filament terminal and ground. All of the leads of both resistors and by-pass capacitors are kept as short as possible, to minimize circuit interaction.

Failure of any component within the i-f amplifier circuit affects the over-all operation of the receiver. The operation of the i-f amplifier circuit may be checked by introducing a 12-mc. signal of known amplitude into the circuit at test point D, (see figure 17), and then measuring the signal at the output of the circuit. However, due to the difficulty of making such a measurement, the output of the over-all receiver is generally used for indicating the condition of the i-f amplifier circuit, after it has been determined first that all of the circuits between the i-f amplifier circuit and the output of the receiver are in good operating condition. A 12-mc. signal of known amplitude introduced into the circuit at test point D will produce a specific receiver-output indication only when the i-f amplifier circuit is operating normally. Failure to obtain the proper indication points to trouble in one of the stages of the circuit, indicating a need for further checks. By introducing a 12-mc. signal of known amplitude progressively into, first, the detector circuit, then the 3rd i-f stage, the 2nd i-f stage, the 1st i-f stage, and finally the mixer circuit at test points D1, D2, D3, D4, and D, respectively (see figure 21), an indication of the condition of these stages and circuits will be obtained. Failure to obtain the proper indication at a test point indicates trouble in that circuit or stage. Simple voltage and resistance checks are then used to locate the cause of failure.

LESSON PLAN No. 8

TIME ALLOTTED: ¾ HR.

SUBJECT

The i-f amplifier circuit.

OBJECTIVE

To analyze the i-f amplifier circuit.

INTRODUCTION

The i-f signal which is produced by the conversion process is relatively weak and must be amplified by selective amplifiers, in order to realize the full benefits of the superheterodyne principle.

SUBJECT MATERIAL

1. Purpose of the circuit.
2. Circuit location on the block diagram and on the schematic.
3. Type of circuit and tubes used.
4. Path of the signal through the circuit.
5. Characteristics of the i-f amplifier.
   a. Frequency.
   b. Bandpass.
6. How the wide bandpass is obtained. Its advantages.
7. How the i-f transformers are tuned.
8. Operating bias.
   a. General method of obtaining the necessary operating bias.
   b. Type of bias used by each stage when the C.W. AND MANUAL-MANUAL-A.V.C. switch is in the C.W. AND MANUAL or MANUAL position.
   c. How the cathode bias is obtained.
   d. How the cathode bias is used to control receiver sensitivity.
   e. Purpose of the grid-circuit components of each stage, and how these components are used to provide grid-leak bias.
   f. Type of bias used by each stage when the C.W. AND MANUAL-MANUAL-A.V.C. switch is in the A.V.C. position.
   g. How the cathode bias is obtained.
   h. How the a-v-c bias is provided.
   i. Purpose of the cathode-circuit components.
   j. Purpose of the grid-circuit components of each stage.
9. Purpose of the screen-grid-circuit components.
10. Purpose of the plate-circuit components of the 1st i-f stage.
11. Purpose of the plate-circuit components of the 2nd and 3rd i-f stages.
12. Purpose of the filament-circuit components.
13. Use of test points in checking the operation of the circuit.

CONCLUSIONS

The i-f amplifier circuit used in the BC-639-A provides the receiver with uniform selectivity and sensitivity over its entire range of operating frequencies, and assures the delivery of a substantial signal voltage to the detector circuit for demodulation purposes.

ORAL QUIZ

1. What is the purpose of the i-f amplifier circuit?
2. How many tuned transformers are used in the i-f amplifier circuit?

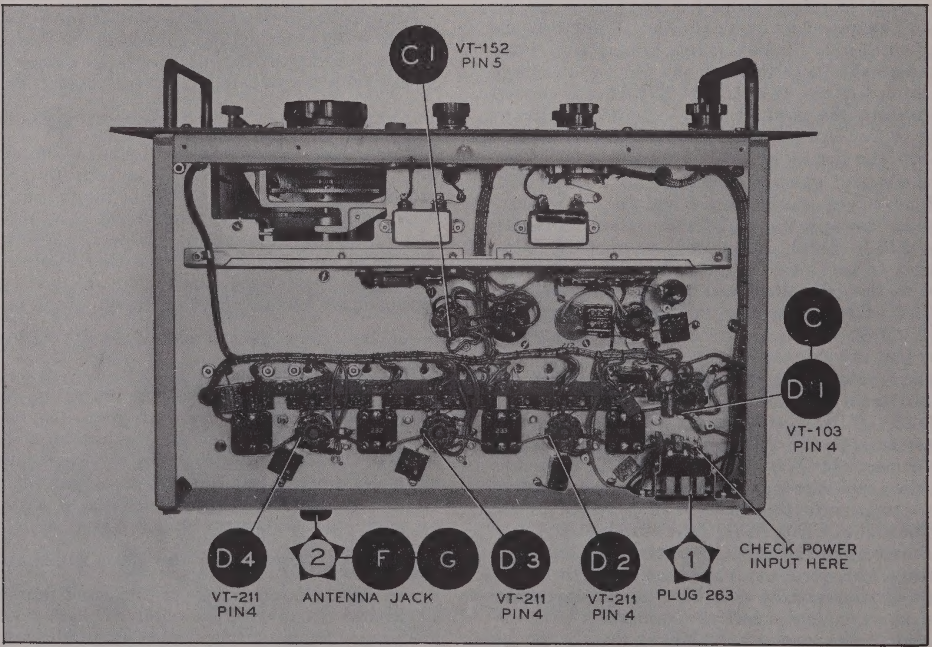


Figure 21. Radio Receiver, Bottom View, Showing Locations of Test Points

3. What type of tubes does it use?
4. What is the bandwidth?
5. How is this bandwidth obtained?
6. What are some of the advantages of having a wide bandpass?
7. How many tuning adjustments does each i-f transformer have?
8. Suppose that one of the i-f transformers can not be tuned properly by means of its adjustments; what components in the transformer, when defective, could cause this condition?
9. How is the operating bias obtained when the C.W. AND MANUAL-MANUAL-A.V.C. switch is in the C.W. AND MANUAL or MANUAL position? In the A.V.C. position?
10. What the purposes of the resistors and capacitors which are connected to the low end of the secondary of each i-f transformer?
11. When the C.W. AND MANUAL-MANUAL-A.V.C. switch is in the A.V.C. position, what normally determines the maximum sensitivity of the i-f amplifier circuit?
12. To which stages is a-v-c bias voltage applied?
13. When do these stages operate with only cathode bias?
14. What is the purpose of the TUNING METER?
15. What does it indicate?
16. Why does the TUNING METER indication vary when a strong signal is being tuned in?
17. What is the normal TUNING METER reading when no signal is being received?
18. How can the operation of the over-all i-f amplifier circuit be checked?
19. How can the stages be checked individually?
20. What are the frequency characteristics of the 1st and 2nd i-f transformers?

LECTURE No. 9

CIRCUIT ANALYSIS OF DETECTOR

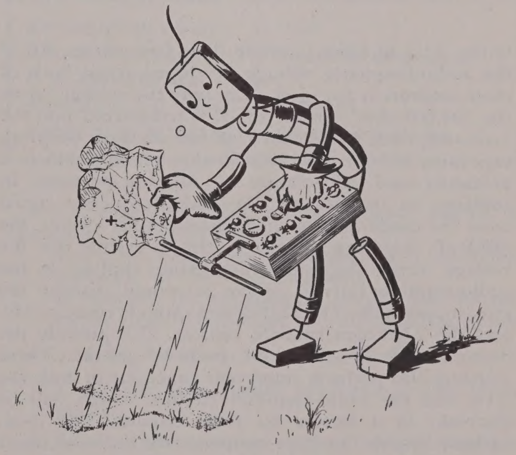
The detector circuit used in the BC-639-A demodulates the 12-mc. i-f signal provided by the i-f amplifier circuit. It is located at the right rear of the receiver chassis (see figure 9), and is shown in block form in figure 15 and in schematic form in figure 22. The detector circuit, as shown on the schematic, is of the diode type, and uses one of the two diode plates of the duo-diode-triode tube, VT-103 (6SQ7). Portions of this tube are also used in the a-v-c and audio-amplifier circuits.

When the 12-mc. signal from the i-f amplifier circuit is introduced into the detector circuit, rectification of the signal occurs, causing pulses of unidirectional current to flow through the diode load resistors, 236-4 and 236-5. Since the amplitude of the signal voltage introduced into the detector circuit varies with the modulation, contained in the incoming signal or provided by heterodyne action of the b-f-o signal, the amplitude of the current pulses through the diode resistors, as well as the amplitude of the pulsating voltage resulting from this current flow, also varies in accordance with the modulation.

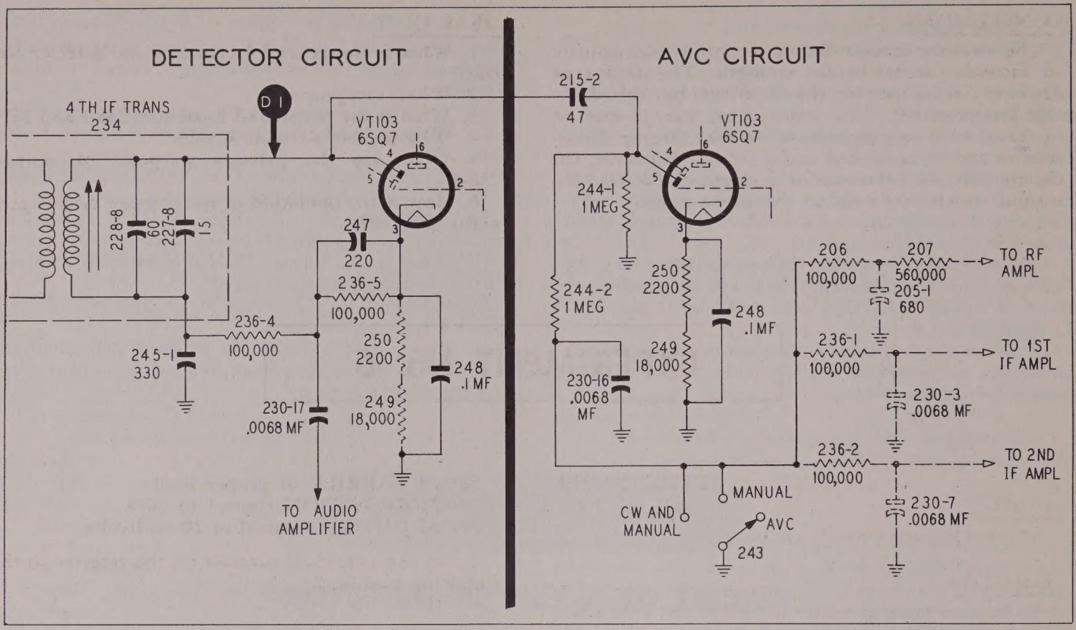
From detector theory, it can be shown that the voltage produced by detector action contains the following components.

a. An i-f component.
b. Several harmonic-frequency components.
c. A d-c component.
d. An audio-frequency component.

Since only the audio-frequency component of the voltage is desired, all of the other components must be eliminated in the demodulation process. The i-f and harmonic-frequency components are eliminated by filters, which smooth out the pulses of current flowing through the diode-load resistors. The d-c component is eliminated by using capacitor 230-17 to introduce the signal into the audio-frequency amplifier circuit. This capacitor blocks the d-c component but offers very little opposition to the audio-frequency component of the voltage, thus completing the demodulation process.



The 100,000-ohm diode-load resistors, 236-4 and 236-5, the 330-uuf. diode-load filter capacitor, 245-1, and the 220-uuf. diode-load filter capacitor, 247, are a part of the detector-circuit load, and also serve as a filter in removing the undesirable components resulting from the demodulation process. The small capacitance values which are used are essential to the demodulation process, since the capacitors must offer a low impedance to both the i-f and harmonic frequencies in order to shunt these frequencies to ground, and must offer a high impedance to the audio frequency (pul-


DETECTOR CIRCUIT
AVC CIRCUIT
4 TH IF TRANS
234
D1
VT103
6SQ7
228-8
60
227-8
15
247
220
236-5
100,000
236-4
100,000
245-1
330
250
2200
248
.1 MF
249
18,000
230-17
.0068 MF
TO AUDIO AMPLIFIER
215-2
47
VT103
6SQ7
244-1
1 MEG
244-2
1 MEG
250
2200
248
.1MF
249
18,000
230-16
.0068
MF
206
100,000
207
560,000
205-1
680
TO RF AMPL
236-1
100,000
TO 1ST IF AMPL
230-3
.0068 MF
236-2
100,000
TO 2ND IF AMPL
230-7
.0068 MF
MANUAL
CW AND MANUAL
AVC
243

TP9-1324

Figure 22. Schematic Diagram of Detector and A-V-C Circuits

sating d.c.) in order to retain these frequencies. All of the audio-frequency voltage developed across both of these resistors is not used, since only the voltage across the 100,000-ohm resistor, 236-5, is transferred into the audio-amplifier circuit, through the .0068-uf. coupling capacitor, 230-17. The 100,000-ohm resistor, 236-4, is primarily used for isolation and filtering purposes. In addition to transferring the audio-frequency signal from the diode load to the audio-amplifier circuit, the .0068-uf. coupling capacitor also prevents the d-c voltage across the load from being applied to the audio-amplifier circuit where it would disrupt the circuit operation. The 18,000-ohm cathode resistor, 249, and the 2200-ohm cathode resistor, 250, provide the detector circuit with a d-c path to ground. These resistors also perform important functions in both the a-v-c and the audio-amplifier circuits, which will be discussed in a lecture on these circuits. The .1-uf. cathode by-pass capacitor maintains the cathode circuit of the detector-a.v.c.-1st audio-amplifier tube at both r-f and a-f ground potential.

Failure of any component within this circuit affects the over-all operation of the receiver. The operation of the detector circuit may be checked by introducing a 12-mc. modulated signal of high amplitude into the circuit at test point D1 (see figure 21), and then measuring the signal output of the circuit. Generally, however, the output of the over-all receiver is used to indicate the condition of the detector circuit after it has been determined first that the audio-amplifier circuit is in good operating condition. Failure to obtain the proper output indication points to trouble in this circuit. Simple voltage and resistance measurements are then used to locate the cause of the circuit failure.

LESSON PLAN No. 9

TIME ALLOTTED: 1/3 HR.

SUBJECT

Detector circuit.

OBJECTIVE

To analyze the detector circuit.

INTRODUCTION

Since the intelligence which is impressed upon the carrier signal at the transmitter is still contained in the modulated 12-mc. signal at the output of the i-f amplifier and since this intelligence cannot be extracted from the signal by feeding it directly into a reproducing device, a means of separating this intelligence from the i-f signal must be incorporated in the receiver. The process of separating the intelligence is known as demodulation, or detection, and is essentially one of rectification.

SUBJECT MATERIAL

1. Purpose of the circuit.
2. Circuit location on the block diagram and on the schematic.
3. Type of circuit and tube used.
4. Analysis of circuit operation.
5. Purpose of the circuit components.
6. Use of test points in checking the operation of the circuit.

CONCLUSIONS

The detector circuit should faithfully demodulate an incoming signal of any strength. The diode-type detector circuit used in the BC-639-A has this desirable characteristic. The input-signal voltage may be increased to a very high level without causing distortion in the demodulated audio signal. However, the circuit will not overcome or compensate for any distortion which may exist in the input signal.

ORAL QUIZ

1. What is the general location of the detector circuit?
2. What is its purpose?
3. What is the purpose of capacitors 245-1 and 247?
4. Why are they so small in value?
5. What are the primary purposes of resistor 236-4?
6. How is the operation of the detector circuit generally checked?

EXPERIMENT No. 6

TIME ALLOTTED: 2½ HR.

SUBJECT

I-f amplifier and detector circuits.

OBJECTIVE

To become familiar with the normal test indications of the i-f amplifier and detector circuits, and with the method used in checking their operation.

EQUIPMENT REQUIRED

1 Radio Receiver BC-639-A.
1 Rectifier Unit RA-42-B.
1 Power-supply cable equipped with two Jones connector sockets.
1 Multimeter (20,000-ohm-per-volt sensitivity).
1 R-f signal generator (same as used in Experiment No. 3.)
1 600-ohm, two-watt carbon resistor.
1 Headset.

INSTRUCTIONS

After removing the receiver from the dust cover, connect it to the power supply, using the power-supply cable equipped with the two Jones connector sockets. Insert the headset plug into the MONITOR jack on the receiver front panel. Connect the power supply to the power source, and operate the POWER ON switch to on. (Do not apply power to the receiver unless a load is connected across its output.) Also connect the r-f signal generator to the power source and operate its POWER switch to ON. Allow both the receiver and the signal generator to warm-up for several minutes before continuing with the procedure.

Do not change the position of the operating controls on either the receiver or the test equipment unless directed to do so. Make only the tests outlined.

PROCEDURE

1. Set the operating controls on the r-f signal generator to the following positions:

Set POWER switch to ON.
Set MODULATION switch to INTERNAL.
Set generator output frequency to 12 mc.
Set r-f CARRIER to proper level.
Set MODULATION control to 30%.
Set r-f OUTPUT control to 20 millivolts.

2. Set the operating controls on the receiver to the following positions:

CONTROL	POSITION
ATTENUATION switch	0 DB.
R. F. GAIN INCREASE	Maximum clockwise
C. W. AND MANUAL-MANUAL-A. V. C. switch	MANUAL
AUDIO GAIN INCREASE	Maximum clockwise

3. To determine whether the detector circuit is operating, proceed as follows:

a. Connect the grounded output lead of the signal generator to the receiver chassis.

b. Connect the ungrounded output lead of the signal generator through a .1-uf. capacitor to pin 4 of the detector tube (test point D1).

c. A clear tone should be heard in the headphones.

4. To determine whether each of the i-f amplifier stages is operating, proceed as follows:

a. Connect the ungrounded output lead of the signal generator through a .1-uf. capacitor in sequence to pin 4 of the 3rd, 2nd, and 1st i-f amplifier tubes (test points D2, D3, and D4, respectively) and to pin 1 of the mixer tube (test point D).

NOTE: The mixer tube is assumed to be operating normally.

b. Adjust the OUTPUT control on the signal generator to the position given for each test point in the following chart:

OUTPUT CONTROL SETTING	SIGNAL GENERATOR CONNECTED TO
20 millivolts	Test point D2
2 millivolts	Test point D3
200 microvolts	Test point D4
20 microvolts	Test point D

c. In each case, a loud, clear tone should be heard in the headset.

NOTE: Since the test signal which is introduced into the grid of the mixer tube (pin 1, test point D1) passes through all of the i-f amplifier stages and is finally applied to the detector circuit where it is demodulated, it is obvious that this test point may be used to check simultaneously the operation of the detector circuit and all of the stages in the i-f amplifier circuit.

5. To determine the amplification, or gain, of the 3rd i-f amplifier stage, proceed as follows:

a. Connect the multimeter (30-volt a-c range) or an output meter in parallel with a 600-ohm, two-watt carbon resistor, or its equivalent, across terminals 11 and 12 of the receiver power-supply plug, 263.

b. Remove the headset plug from the MONITOR jack on the receiver front panel.

c. Connect the ungrounded output lead of the signal generator through a .1-uf. capacitor to pin 4 of the detector tube (test point D1).

d. Adjust the OUTPUT control on the signal generator for a receiver-output indication of 2.5 volts (if it is impossible to obtain a 2.5-volt output indication, leave the signal-generator OUTPUT control at maximum). Record both the output indication obtained and the setting of the signal-generator OUTPUT control.

e. Disconnect the signal-generator output lead from test point D1 and connect it to pin 4 of the 3rd i-f amplifier tube (test point D2).

f. Adjust the OUTPUT control on the signal generator for the same receiver-output indication as that recorded in step 5.d.

g. Adjust the tuning control on the signal generator for maximum receiver output.

h. Repeat step 5.f., and record the setting of the OUTPUT control.

i. Calculate the gain of the 3rd i-f amplifier stage by dividing the OUTPUT control setting recorded in step 5.d. by that recorded in step 5.h.

6. To determine the gain of the 2nd i-f amplifier stage, proceed as follows:

a. With the signal generator connected to test point D2 (pin 4 of the 3rd i-f amplifier), adjust the signal-generator OUTPUT control for a receiver-output indication of 5 volts; then record the setting of the OUTPUT control.

b. Disconnect the signal-generator output lead from test point D2 and connect it to pin 4 of the 2nd i-f amplifier tube (test point D3).

c. Adjust the signal-generator OUTPUT control for a receiver-output indication of 5 volts; then record the setting of the OUTPUT control.

d. Calculate the gain of the 2nd i-f amplifier stage by dividing the OUTPUT control setting recorded in step 6.a. by that recorded in step 6.c.

7. To determine the gain of the 1st i-f amplifier stage, proceed as follows:

a. With the signal generator connected to test point D3, adjust the signal-generator OUTPUT control for a receiver-output indication of 5 volts. Record the setting of the OUTPUT control.

b. Disconnect the signal-generator output lead from test point D3, and connect it to pin 4 of the 1st i-f amplifier tube (test point D4).

c. Adjust the signal-generator OUTPUT control for a receiver-output indication of 5 volts; then record the setting of the OUTPUT control.

d. Calculate the gain of the 1st i-f amplifier stage by dividing the OUTPUT control setting recorded in step 7.a. by that recorded in step 7.c.

8. To determine the over-all gain of the i-f amplifier circuit, proceed as follows:

NOTE: In this test the amplification of the mixer tube is included in the measurement.

a. Disconnect the signal-generator output lead from test point D4 and connect it to pin 1 of the mixer tube (test point D).

b. Adjust the tuning control on the signal generator for maximum receiver output; then record the frequency setting of the signal generator.

c. Adjust the signal-generator OUTPUT control for the same receiver-output indication that was recorded in step 5.d. Record the setting of the OUTPUT control.

d. Calculate the gain of the over-all amplifier circuit by dividing the OUTPUT control setting recorded in step 5.d. by that recorded in step 8.c.

9. To determine the effect of the R.F. GAIN INCREASE control upon the gain of the over-all i-f amplifier circuit when the C.W. AND MANUAL-MANUAL-A.V.C. switch is in the MANUAL and A.V.C. positions proceed as follows:

a. Adjust the signal-generator OUTPUT control for a receiver-output indication of 5 volts.

b. Slowly adjust the R. F. GAIN INCREASE control in a counterclockwise direction, and note the effect upon the gain of the i-f amplifier circuit, as indicated by the change in receiver output.

c. Reset the R. F. GAIN INCREASE control to maximum. Set the C.W. AND MANUAL-MANUAL-A.V.C. switch to A.V.C.

d. Repeat step 9.b.

10. Reset the R.F. GAIN INCREASE control to maximum; reset the C.W. AND MANUAL-MANUAL-A.V.C. switch to the MANUAL position.

11. To determine the effect of the THRESHOLD SENSITIVITY control upon the gain of the over-all i-f amplifier circuit, proceed as follows: Slowly adjust the THRESHOLD SENSITIVITY control, first in a clockwise direction and then in a counterclockwise direction. Note the effect upon the gain of the i-f amplifier circuit, as indicated by the change in receiver output.

12. Reset the THRESHOLD SENSITIVITY control for a receiver-output indication of 5 volts.

13. To determine the bandpass of the over-all i-f amplifier circuit, proceed as follows:

a. Adjust the tuning control on the signal generator in a clockwise direction until the output indication of the receiver drops to 2.5 volts. Record the frequency setting of the signal generator.

b. Adjust the tuning control on the signal generator in a counterclockwise direction, past the point of peak receiver output, until the output indication of the receiver is again 2.5 volts. Record the frequency setting of the signal generator.

c. Calculate the bandpass of the i-f amplifier circuit by subtracting the lowest frequency recorded in steps 13.a. and 13.b. from the highest.

14. To determine the effect of improperly tuned i-f transformers upon the gain and bandpass of the i-f amplifier circuit, proceed as follows:

a. Adjust the tuning control on the signal generator for maximum receiver output. Then record the frequency setting of the signal generator.

b. Adjust the signal-generator OUTPUT control for a receiver-output indication of 5 volts. Then record the setting of the OUTPUT control.

c. Readjust the signal-generator OUTPUT control for a receiver-output indication of 10 volts.

d. Detune the 3rd and 4th i-f transformers so that an output indication of 5 volts is obtained.

e. Compare the OUTPUT control setting recorded in step 14.b. with that indicated on the signal-generator OUTPUT control in step 14.c. Note the effect which detuning has upon the gain of the i-f amplifier circuit, as indicated by the increased signal input required to produce the 5-volt receiver-output indication.

f. Repeat step 13.a.

g. Repeat step 13.b.

h. Calculate the bandpass of the i-f amplifier circuit by subtracting the lowest frequency recorded in steps 14.f. and 14.g. from the highest.

i. Compare the bandpass calculated in step 13.c. with that calculated in step 14.h. and note the effect which detuning has upon the bandpass of the receiver.

15. Restore the 3rd and 4th i-f transformers to their original correctly tuned condition, as follows:

a. Reset the tuning control on the signal generator for the frequency recorded in step 14.a.

b. Reset the adjustments on the 4th i-f transformer for maximum receiver-output indication.

c. Adjust the signal-generator OUTPUT control for a receiver-output indication of 5 volts.

d. Reset the adjustments on the 3rd i-f transformer for maximum receiver-output indication.

e. Repeat step 15.c.

f. In sequence repeat steps 15.b., 15.c., and 15.d.

16. Disconnect the signal generator from the receiver.

17. Using the multimeter as a voltmeter, measure the voltages between the tube-socket terminals and the chassis. Record the voltage readings in the following chart:

TUBE SOCKET	PIN No.	SETTING OF C. W. AND MANUAL-MANUAL-A. V. C. CONTROL	SETTING OF R. F. GAIN INCREASE CONTROL	VOLTAGE
1st i-f amplifier	3	MANUAL	Maximum	
	5	MANUAL	Maximum	
	6	MANUAL	Maximum	
	8	MANUAL	Maximum	
	3	MANUAL	Minimum	
	5	MANUAL	Minimum	
	3	A. V. C.	Minimum	
	5	A. V. C.	Minimum	
	3	A. V. C.	Maximum	
	5	A. V. C.	Maximum	
2nd i-f amplifier	3	MANUAL	Maximum	
	5	MANUAL	Maximum	
	6	MANUAL	Maximum	
	8	MANUAL	Maximum	
	5	MANUAL	Minimum	
	5	A. V. C.	Minimum	
	5	A. V. C.	Maximum	
3rd i-f amplifier	3	MANUAL	Maximum	
	5	MANUAL	Maximum	
	6	MANUAL	Maximum	
	8	MANUAL	Maximum	
	5	MANUAL	Minimum	
	5	A. V. C.	Minimum	
	5	A. V. C.	Maximum	

15. Operate the POWER ON switch on the power-supply unit to off. Using the multimeter as an ohmmeter, measure and record the resistance between the receiver chassis and the points indicated in the following chart:

5. What effect does the R.F. GAIN INCREASE control have upon the gain of the i-f amplifier circuit? The THRESHOLD SENSITIVITY control?

6. What effect do mistuned i-f transformers have upon the over-all sensitivity of the receiver? Upon the over-all selectivity?

TUBE SOCKET	PIN No.	OPERATING CONTROL	POSITION	RESISTANCE IN OHMS	CIRCUIT COMPONENTS MEASURED
1st i-f amplifier	4	C. W. AND MANUAL-	A. V. C.		
	4	MANUAL-A. V. C.	MANUAL		
	5	R. F. GAIN	MAXIMUM		
	5	INCREASE	MINIMUM		
	5	C. W. AND MANUAL-	A. V. C.		
	6	MANUAL-A. V. C.	A. V. C.		
	8		A. V. C.		
2nd i-f amplifier	4	C. W. AND MANUAL-	A. V. C.		
	4	MANUAL-A. V. C.	MANUAL		
	5	R. F. GAIN	MAXIMUM		
	5	INCREASE	MINIMUM		
	5	C. W. AND MANUAL-	A. V. C.		
	6	MANUAL-A. V. C.	A. V. C.		
	8		A. V. C.		
3rd i-f amplifier	4	C. W. AND MANUAL-	A. V. C.		
	4	MANUAL-A. V. C.	MANUAL		
	5	R. F. GAIN	MAXIMUM		
	5	INCREASE	MINIMUM		
	5	C. W. AND MANUAL-	A. V. C.		
	6	MANUAL-A. V. C.	A. V. C.		
	8		A. V. C.		
Detector	4				
	3				

16. After completing this portion of the experiment, request the instructor to put trouble into the i-f amplifier and detector circuits. Using the tests given in preceding portion of this experiment, locate and correct the trouble.

CONCLUSIONS

1. What one test may be used to check the over-all operation of the detector and i-f amplifier circuits?

2. How can the circuits be checked individually?

3. If the 2nd i-f amplifier stage is inoperative, what test procedure should be followed in locating the defective stage?

4. How may an insensitive i-f stage be located?

7. What is the approximate bandpass of the i-f amplifier circuit when it is properly tuned?

8. What tube-element voltage is changed when the R.F. GAIN INCREASE control is rotated?

9. What effect would a shorted 2nd i-f amplifier cathode-by-pass capacitor have upon the operation of the receiver?

10. What effect would improper adjustment of the THRESHOLD SENSITIVITY control have upon the sensitivity of the receiver?

11. What resistance should be indicated between the cathode (pin 5) of the 1st i-f amplifier stage and the receiver chassis when the C.W. AND MANUAL-MANUAL-A.V.C. switch is in the A.V.C. position?

REVIEW No. 1

TIME ALLOTTED: 3 HR.

This review is to be conducted in the form of an oral quiz. Display both the block diagram and the schematic diagram of the receiver, to aid the student in answering the questions. Review the important points contained in Lectures No. 1 through No. 9, and Experiments No. 1 through No. 6, by asking the questions contained in the Oral Quiz of each Lesson Plan and in the Conclusions of each Experiment. If any particular question causes the students difficulty, be sure to explain the answer fully. At regular intervals during the review, permit the students to ask questions of their own pertaining to the subject material. Make a note of each question on which the students indicate a general weakness. These questions should be covered again in subsequent reviews.

EXAMINATION No. 1

TIME ALLOTTED: 2 HR.

This examination covers the material contained in Lectures No. 1 through No. 9 and Experiments No. 1 through No. 6. No reference material may be used during Part I of this examination. After Part I is finished, wait for the instructor to collect the papers. Do not start Part II until directed to do so by the instructor. The schematic diagram and the block diagram may be used in answering the questions in Part II.

Part I

MULTIPLE-CHOICE QUESTIONS

1. Radio Receiver BC-639-A is used principally as:
   a. a receiver in an aircraft.
   b. a receiver in a v-h-f communications system.
   c. a receiver for receiving commercial broadcasts.
   d. a receiver in an aircraft direction-finding system.
2. The antenna which is generally used with the BC-639-A is:
   a. a rhombic antenna.
   b. a loop antenna.
   c. a dipole antenna.
   d. a beverage antenna.
3. Radio Receiver BC-639-A operates over a frequency range of:
   a. 550 kc.—1500 kc.
   b. 10 mc.—15 mc.
   c. 100 mc.—156 mc.
   d. 400 mc.—460 mc.
4. The BC-639-A is designed to receive:
   a. only modulated signals.
   b. modulated and c-w signals.
   c. only c-w signals.
   d. frequency-modulated signals.
5. The tuning control on the front panel of the receiver tunes:
   a. the beat-frequency-oscillator circuit.
   b. the i-f amplifier circuit.
   c. the h-f oscillator circuit.
   d. the r-f amplifier, mixer, h-f oscillator, and doubler circuits.
6. The r-f sensitivity of the receiver is manually controlled by:
   a. the ATTENUATION control.
   b. the C.W. TONE CONTROL.
   c. both the THRESHOLD SENSITIVITY control and the R.F. GAIN INCREASE control.
   d. the AUDIO GAIN INCREASE control.
7. The SUPPLY VOLTAGE control on the front panel of Rectifier Unit RA-42-B is used to:
   a. switch over from power-line operation to battery operation.
   b. switch from a-c power-line operation to d-c power-line operation.
   c. switch from 110-volt a-c power-line operation to 220-volt a-c power-line operation.
   d. compensate for variations in power-source voltage.
8. The beat-frequency (c-w) oscillator is in operation whenever:
   a. the C.W. TONE CONTROL is in the maximum counterclockwise position.
   b. the C.W. AND MANUAL-MANUAL-A.V.C. switch is in the C.W. AND MANUAL position.
   c. the C.W. AND MANUAL-MANUAL-A.V.C. switch is in the A.V.C. position.
   d. the ATTENUATION control is in the —12DB position.
9. The frequency range of the h-f oscillator is:
   a. 100—156 mc.
   b. 50—78 mc.
   c. 11.9—12.1 mc.
   d. 44—72 mc.
10. The output frequency of the mixer tube is:
    a. 456 kc.
    b. 12 mc.
    c. 160 mc.
    d. 70 mc.
11. The bandwidth of the i-f amplifier circuit is:
    a. 140 kc.
    b. 10 kc.
    c. 12 mc.
    d. 50 kc.
12. Poor i-f alignment has very little effect upon:
    a. the over-all sensitivity.
    b. the dial calibration.
    c. the selectivity.
    d. the bandwidth of the i-f amplifier circuit.
13. Good image rejection is obtained through the use of:
    a. a grid-tuned, plate-tuned r-f amplifier circuit.
    b. an oscillator-doubler circuit.
    c. very high transmitting frequencies.
    d. a sharply tuned i-f amplifier circuit.
14. To check the operation of the over-all i-f amplifier circuit:
    a. an audio signal is injected into the 1st i-f amplifier stage.
    b. a 12-mc. i-f signal is fed to the mixer-tube grid.
    c. a 12-mc. i-f signal is fed to the grid of the 1st i-f amplifier stage.
    d. a 130-mc. r-f signal is fed to the mixer-tube grid.
15. When the i-f amplifier circuit is aligned, the 1st and 2nd i-f transformers are adjusted for:
    a. maximum receiver output at 12 mc.
    b. maximum receiver output at 11,300 kc. and at 12,070 kc.
    c. minimum output at 12 mc.
    d. flat-top response 5 kc. each side of 12 mc.

ESSAY QUESTIONS

16. What are the advantages of v-h-f communications over low-frequency communications?

17. Briefly explain the purpose of the ATTENUATION control.

18. Draw the functional block diagram of the equipment.

19. Briefly explain how the THRESHOLD SENSITIVITY control is set for normal receiver operation.

20. Briefly explain how the TUNING METER may be used as a tuning guide to indicate the accuracy of tuning.

Part II

MULTIPLE-CHOICE QUESTIONS

21. The insertion of a headphone plug into the LINE jack on the receiver front panel:
    a. disconnects the receiver output from the telephone-line circuit.
    b. connects the receiver output to the telephone-line circuit.
    c. disconnects the power supply from the receiver.
    d. makes it possible to monitor the signal simultaneously at both the receiver and the operations center.

22. The local-signal voltage which is fed to the mixer tube is obtained from:
    a. the plate of the h-f oscillator tube.
    b. the doubler circuit.
    c. the r-f amplifier circuit.
    d. the beat-frequency-oscillator circuit.

23. To check the operation of the h-f oscillator, connect:
    a. an r-f signal generator to test point E1 .
    b. a 20,000-ohms-per-volt voltmeter in series with an isolating choke or resistor to test point E1 .
    c. a 1000-ohms-per-volt voltmeter to test point E .
    d. an r-f signal generator to test point F .

24. The purpose of the 1000-ohm resistor and associated by-pass capacitor in the plate circuit of the 2nd i-f amplifier tube is to:
    a. prevent any of the i-f signal from entering the power-supply distribution system.
    b. couple the i-f signal to the 3rd i-f amplifier.
    c. eliminate unwanted frequencies from the 3rd i-f amplifier stage.
    d. keep the b-f-o signal out of the 2nd i-f amplifier stage.

25. If the 1st i-f amplifier screen-grid by-pass capacitor were to short, the receiver would become inoperative due to:
    a. low plate voltage on the 1st i-f tube.
    b. excessive screen current in the 1st i-f tube.
    c. excessive signal on the 2nd i-f tube.
    d. no screen-grid voltage on the 1st i-f tube.

26. If the signal-generator output connection is moved from test point D2 to test point D4 when the i-f amplifier circuit is tested, the output-meter reading should:
    a. decrease.
    b. increase.
    c. remain the same.
    d. be zero.

27. If grid capacitor 276-1 in the h-f oscillator were to short, the receiver would become inoperative due to:
    a. no voltage at test point E1 .
    b. a large negative voltage at test point E1 .
    c. a positive voltage at test point E1 .
    d. no plate voltage on the h-f oscillator tube.

28. If the cathode by-pass capacitor in the 1st i-f amplifier were shorted, the TUNING METER indication would:
    a. increase to a high value.
    b. decrease slightly.
    c. remain the same.
    d. decrease to a low value.

29. If the cathode resistor in the r-f amplifier were open, the receiver would be inoperative due to:
    a. no plate voltage on the r-f amplifier tube.
    b. no cathode voltage on the r-f amplifier tube.
    c. the absence of plate and screen-grid currents in the r-f amplifier tube.
    d. a low screen-grid voltage on the r-f amplifier tube.

30. When the C.W. AND MANUAL-MANUAL-A.V.C. switch is in the MANUAL position, the value of the grid bias voltage on the 3rd i-f amplifier tube is determined by:
    a. the setting of both the THRESHOLD SENSITIVITY control and the R.F. GAIN INCREASE control.
    b. the value of the grid resistor, 236-3.
    c. the value of the screen-grid voltage.
    d. the strength of the incoming signal.

ESSAY QUESTIONS

31. Explain why the R.F. GAIN INCREASE control affects the TUNING METER reading when the C.W. AND MANUAL-MANUAL-A.V.C. switch is in either the C.W. AND MANUAL or MANUAL position.

32. What factors determine the accuracy of the MEGACYCLES dial readings?

33. Explain how the use of a high intermediate frequency aids in image rejection.

34. Briefly describe the procedure for locating an insensitive i-f stage.

35. Name two important functions which the detector circuit performs in demodulating the r-f signals.

▶ REVIEW OF EXAMINATION No. 1 ◀

TIME ALLOTTED: 1 HR.

Display both the block diagram and the schematic diagram of the receiver. Using the examination, review each question and give the correct answer. Answer in detail any questions which cause the students difficulty. At regular intervals permit the students to ask questions of their own, and to engage in classroom discussions pertaining to those questions. Make a note of the questions on which the students indicate a general weakness. These questions should be covered again in subsequent reviews.

LECTURE No. 10

ANALYSIS OF AUTOMATIC-VOLUME-CONTROL CIRCUIT

The automatic-volume-control circuit used in the BC-639-A automatically varies the sensitivity of the receiver in a manner which compensates for any changes in signal intensity, thus assuring a fairly constant audio output from the receiver at all times. This circuit is located at the right side of the receiver chassis and is shown in block form in figure 15 and in schematic form in figure 22. The a-v-c circuit is of the delayed type, and uses one of the two diode plates of the duo-diode-triode tube, VT-103-(6SQ7), as shown on the schematic. Portions of this tube are also used in the detector and audio-amplifier circuits.

The a-v-c circuit operates in the same manner as the detector circuit. When a modulated 12-mc. i-f signal of sufficient strength is introduced into the a-v-c circuit through the 47-uuf. coupling capacitor, 215-2, the a-v-c diode conducts, rectifying the i-f signal and causing a unidirectional current to flow through the one-megohm diode-load resistor, 244-1. The voltage resulting from this current flow is unsuitable for a.v.c. until it is properly filtered, since it consists of the following components:

a. An i-f component.
b. Several harmonic-frequency components.
c. An audio-frequency component.
d. A d-c component.

The use of the proper kind of filter network eliminates the i-f, harmonic-frequency, and audio-frequency components, leaving only a negative d-c voltage which varies in amplitude with the average strength of the incoming signal. The stronger the signal, the greater the a-v-c voltage and vice versa. When the C.W. AND MANUAL-MANUAL-A.V.C. switch is in the A.V.C. position, the gain of the r-f amplifier circuit and the 1st and 2nd stages of the i-f amplifier circuit is controlled by this voltage, which is applied as a bias to these circuits.

When the intensity of the incoming signal increases, the increased a-v-c bias voltage decreases the gain of the circuit; when the intensity decreases, the decreased a-v-c bias voltage increases the gain of the circuits. Thus changes in signal intensity are automatically compensated for so that the output of the receiver remains fairly constant. However, when the intensity of the signal falls below a certain specific level, the a-v-c circuit ceases to function, because of the delay voltage, or bias, produced by the triode current flowing through the common cathode resistors, 249 and 250. When this delay voltage is greater than the incoming signal, it prevents the a-v-c diode from conducting; therefore, no a-v-c voltage is produced. Thus for weak signals, the maximum amount of amplification is provided, the gain being limited only by the setting of the THRESHOLD SENSITIVITY control as previously explained. This is one advantage of the delayed type of a-v-c circuit. In a-v-c circuits which do not use a delay voltage, the a-v-c circuit operates even when a very weak signal is being received, so that the gain of the amplifier circuits is reduced when maximum gain is needed the most. In the BC-639-A, a-v-c action is delayed until the incoming signal is great enough to overcome the delay voltage. When this occurs, the a-v-c circuit functions and produces a bias voltage, as previously explained, which automatically controls the gain of the amplifier circuits. However, when the C.W. AND MANUAL-MANUAL-A.V.C. switch is in either the C.W. AND MANUAL or MANUAL position, this bias voltage is shorted out, thus eliminating the a-v-c action. For either of these two switch positions the sensitivity must be manually regulated when changes in signal intensity occur.

The purpose of the 47-uuf. coupling capacitor, 215-2, is to transfer a portion of the signal from the detector circuit into the a-v-c circuit, without seriously overloading the detector circuit. When the a-v-c diode conducts, a bias voltage is developed across the 1-megohm diode-load resistor, 244-1. The 1-megohm resistor, 244-2, and the .0068-uf. capacitor, 230-16, form the first part of the filter network which removes the undesirable components from the a-v-c bias voltage, before it is fed to the various controlled circuits. Separate filter networks are used in the r-f amplifier circuit and in the 1st and 2nd stages of the i-f amplifier circuits, which in addition to filtering the a-v-c voltage also effectively decouple these circuits from each other and from the a-v-c bus. The filter network for the r-f amplifier circuit consists of the 100,000-ohm resistor, 206, the 560,000-ohm resistor, 207, and the 680-uuf. capacitor, 205-1. The filter networks for each of the i-f stages consist of a 100,000-ohm resistor and a .0068-uf. capacitor. Resistor 236-1 is used with capacitor 230-3 as the 1st i-f stage filter, and resistor 236-2 is used with capacitor 230-7 as the 2nd i-f stage filter. The cathode resistors, 249 and 250, in addition to providing the cathode of the detector-a.v.c-1st audio amplifier tube with a d-c path to ground also provide the a-v-c circuit with a delay voltage and the 1st stage of the audio amplifier with its operating bias. The .1-uf. by-pass capacitor, 248, keeps the cathode of this tube at both r-f and a-f ground potential.

Failure of the components in the a-v-c circuit, with the exception of components in the cathode circuit, may not totally disable the receiver, but will affect its performance. When the C.W. AND MANUAL-MANUAL-A.V.C. switch is in either the C.W. AND MANUAL or MANUAL position, component failures in this circuit, with the exception of the cathode-circuit components, will have little or no effect upon the normal operation of the receiver. However, when the switch is in the A.V.C. position, component failures will cause serious distortion or weak receiver output whenever strong signals are received.

After all of the circuits between the antenna-coupling socket and the a-v-c circuit have been checked and found to be normal, the operation of the a-v-c circuit may be checked by introducing a signal of very low amplitude and of the proper frequency into the antenna-coupling socket, 200, and then observing the indication on the TUNING METER (test point Ⓗ) as the signal input is increased. If the meter readings for the various signal inputs are approximately the same as those given in the chart below, the a-v-c circuit is operating correctly. Failure to obtain the correct readings, indicates trouble in the circuit. Simple voltage and resistance measurements are then used to locate the cause of the failure.

METER READING	SIGNAL INPUT
5 ma. approx.	0 uv
5 ma. approx.	10 uv
4.8 ma. approx.	100 uv
3.2 ma. approx.	1,000 uv
2.0 ma. approx.	10,000 uv
1.2 ma. approx.	100,000 uv

LESSON PLAN No. 10

TIME ALLOTTED: 1/3 HR.

SUBJECT

Automatic-volume-control circuit.

OBJECTIVE

To analyze the automatic-volume-control circuit.

INTRODUCTION

Any change in the intensity of the incoming signal will cause a corresponding change in the sound output of a receiver, unless some means is used to vary the sensitivity or gain of the receiver in inverse proportion to the strength of the incoming signal.

SUBJECT MATERIAL

1. Purpose of the circuit.
2. Circuit location on the block diagram and on the schematic.
3. Type of circuit and tube used.
4. Analysis of circuit operation.
    a. How the a-v-c bias is produced and used.
    b. Effect of low signal strength on circuit operation.
    c. Effect of the C.W. AND MANUAL-MANUAL-A.V.C. switch on the a-v-c action.
5. Purpose of the circuit components.
6. Effect of component failure on receiver operation.
7. Use of test point Ⓗ in checking the operation of the circuit.

CONCLUSIONS

A receiver in which the gain is automatically controlled in inverse proportion to the signal strength has a distinct advantage over the one in which the sensitivity is manually controlled. Automatic volume control tends to keep the audio output of the receiver constant, regardless of changes in the strength of the incoming signal, thereby eliminating the need for frequent adjustment of the volume control.

With manual control of sensitivity, the audio output of the receiver varies with the intensity of the incoming signal and with the change in position of the sensitivity control. Often, especially on strong signals, a small movement of the sensitivity control changes the audio output by a large amount, thus making the adjustment of the volume very critical.

ORAL QUIZ

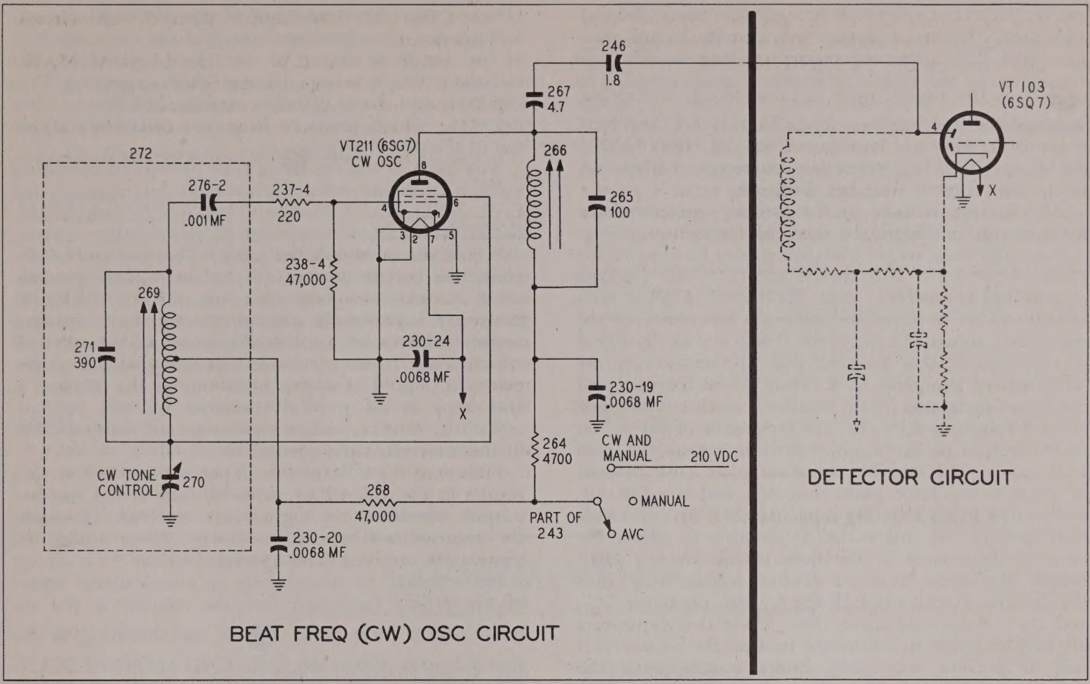
1. What is the purpose of the a-v-c circuit in the BC-639-A?
2. What effect does the strength of the incoming signal have upon the a-v-c voltage?
3. What type of a-v-c circuit is used in the BC-639-A?
4. What is the principal advantage of this type of circuit?
5. How is the delay voltage obtained?
6. Why must the a-v-c voltage be filtered before it can be used for control purposes?
7. Why are separate a-v-c filter networks used in each of the controlled circuits?
8. Why doesn't the a.v.c. have any effect upon the gain of the amplifier circuits when the C.W. AND MANUAL-MANUAL-A.V.C. switch is in either the C.W. AND MANUAL or MANUAL position?
9. How can the a-v-c circuit be checked?

LECTURE No. 11

CIRCUIT ANALYSIS OF BEAT-FREQUENCY (C-W) OSCILLATOR

The beat-frequency (c-w) oscillator circuit used in the BC-639-A causes an audible tone to be produced whenever c-w (dot-dash telegraph) signal or unmodulated (c-w) direction-finding signals are received.

To accomplish its purpose, the beat-frequency oscillator (b.f.o.) generates an r-f signal whose frequency is slightly different from the intermediate frequency of the receiver. The frequency of the signal and, hence, the difference between it and the intermediate frequency are manually controlled over a small range by the operator through the use of the C.W. TONE CONTROL. When this r-f signal is introduced into the detector circuit along with the incoming c-w i-f signal, heterodyne action between the two signals produces a difference frequency, which appears as an audio tone at the output of the receiver. Varying the frequency of the b-f-o signal varies the pitch of the audio tone.


246
1.8
267
4.7
VT211 (6SG7)
CW OSC
266
265
100
272
276-2
.001 MF
237-4
220
238-4
47,000
269
271
390
230-24
.0068 MF
X
230-19
.0068 MF
264
4700
CW AND
MANUAL
210 VDC
CW TONE
CONTROL
270
268
47,000
O MANUAL
PART OF
243
AVC
230-20
.0068 MF
BEAT FREQ (CW) OSC CIRCUIT
VT 103
(6SQ7)
X
DETECTOR CIRCUIT

TP9-1325

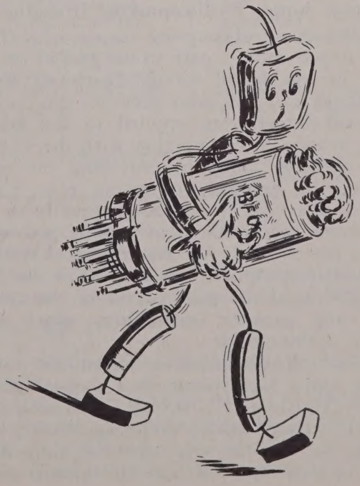
Figure 23. Schematic Diagram of Beat-Frequency (C-W) Oscillator Circuit

The circuit components of the b.f.o. are located at the right center of the receiver chassis (figures 9, 10, and 11). The circuit, itself, is shown in block form in figure 15, and in schematic form in figure 23. The circuit uses a remote-cut-off pentode tube, VT-211 (6SG7), in a type of electron-coupled oscillator circuit. The circuit is a little unusual in that the grid circuit is tuned to half the frequency of the plate circuit, primarily for the purpose of preventing the b.f.o. from locking in with the incoming c-w i-f signal. Interaction of this type would result in failure of the receiver to produce an audible tone whenever c-w signals are received.

The b-f-o circuit used in the BC-639-A may be considered as being divided into two sections: the oscillator section and the frequency-doubler section.

The oscillator section uses the screen grid of the tube as the oscillator anode, and generates oscillations by feeding back energy in proper phase from the anode circuit to the grid circuit. As shown in figure 23, the screen grid of the tube is connected to the low end of the c-w oscillator coil, 269, and the grid is connected to the high end. The tap near the center of the coil is effectively connected to ground through the .0068-uf. capacitor, 230-20. The oscillator coil may be considered as being divided into two parts, with one part serving as the anode (screen-grid) load of the tube and the other part as the control-grid load. When the circuit is in operation, the voltage appearing across the anode-load part of the coil induces a voltage of opposite phase into the grid-load part of the coil, due to the inductive coupling between the two parts. This induced voltage is applied to the grid of the tube through the .001-uf. capacitor, 276-2, thus satisfying the conditions necessary for generating oscillations.

The frequency generated by this circuit is dependent upon the tuning of its tank circuit, which consists of the c-w oscillator coil, 269, the variable capacitor, 270



(C.W. TONE CONTROL), and the fixed 390-uuf. capacitor, 271. An adjustable iron core in the c-w oscillator coil, 269, makes it possible to adjust the resonant frequency of the tank circuit over a small range. The tank circuit is normally tuned to 6 mc. with this adjustable iron core when the C.W. TONE CONTROL is set to the center of its range. The C.W. TONE CONTROL may then be used to vary the resonant frequency of the tank slightly in either direction.

The signal generated by the oscillator section of the b-f-o circuit is transferred into the frequency-doubler section by means of the electron stream flowing to the plate of the tube. Due to the nature of the electron stream (plate current) and the use of a plate tank circuit which is tuned to twice the frequency of the oscillatory signal (12 mc.), the frequency of the signal is doubled in this section, and appears across the terminals of the plate tank. Thus if the frequency of the signal generated by the oscillator section is changed from 5.95 mc. to 6.05 mc., the frequency of the signal at the output of the doubler section is changed from 11.9 mc. to 12.1 mc. The resonant plate tank consists of the c-w oscillator plate coil, 266, and the 100-uuf. c-w-oscillator plate-tuning capacitor, 265. An adjustable iron core in the coil makes it possible to adjust the resonant frequency of the tank circuit over a small range. The signal from the doubler section is fed into the detector circuit through the 4.7-uuf. capacitor, 267, and the 1.8-uuf. capacitor, 246. These two capacitors are used in series, to reduce the load on the b-f-o circuit and to prevent too much interaction between the detector and b-f-o circuits.

In the detector circuit, heterodyne action between this r-f signal and the incoming 12-mc. i-f signal produces an audio signal, which after being amplified appears as an audio tone in the sound reproducer. The pitch of the tone depends upon the frequency difference between the two heterodyning signals.

The b-f-c circuit may be switched in or out of operation, as desired, by simply changing the setting of the C.W. AND MANUAL-MANUAL-A.V.C. switch, 243. When the switch is in the C.W. AND MANUAL position, the circuit is in operation. When the switch is in either of the other two positions (MANUAL or A.V.C.), the circuit is not in operation, since the main high-voltage supply is disconnected from the circuit.

The .001-uf. grid-coupling capacitor, 276-2, in addition to providing a path to the grid of the oscillator tube for the signal voltage developed across the c-w oscillator coil 269, also prevents the d-c voltage on the coil from being applied to the grid. This capacitor is used in conjunction with the 47,000-ohm grid-leak resistor 238-4, in providing the oscillator tube with the necessary operating bias. Since the cathode of the tube is connected directly to ground and since no other source of bias is provided, the operating bias is solely the result of grid rectification of the oscillatory signal. The purpose of the 220-ohm resistor, 237-4, in the grid circuit of the tube is to suppress any parasitic oscillations which may be developed in this circuit.

The operating voltage for the screen grid is obtained from the main high-voltage bus through the C.W. AND MANUAL-MANUAL-A.V.C. switch, 243, the 47,000-ohm screen (anode) dropping resistor, 268, and the lower half of the c-w oscillator coil, 269. The .0068-uf. by-pass capacitor, 230-20, which is connected between the center terminals of the c-w oscillator coil and ground, completes both the grid and anode circuits of the oscillator section of the tube by providing the circuits with a low-impedance r-f path to ground. This capacitor and the 47,000-ohm resistor, 268, form a filter network, which tends to keep the oscillatory signal out of the power supply.

The plate of the oscillator tube obtains its operating voltage from the main high-voltage bus through the C.W. AND MANUAL-MANUAL-A.V.C. switch, 243, the 47,000-ohm c.w. oscillator plate dropping resistor, 264, and the plate-load coil, 266. The low end of the plate-load coil is kept at r-f ground potential by the .0068-uf. plate by-pass capacitor, 230-19, which is connected between the coil and ground. This capacitor and the 47,000-ohm resistor, 264, form a filter network which tends to keep the oscillatory signal out of the power supply. The ungrounded side of the filament is also kept at r-f ground potential by the .0068-uf. capacitor, 230-24, which is connected between the filament terminal and ground.

Failure of the b-f-o circuit in performing its function results in the absence of an audio tone at the receiver output whenever c-w signals are received. However, the receiver will operate normally when modulated signals are received. The operation of the b-f-o circuit is best checked by introducing an unmodulated signal of the proper frequency into the receiver at the antenna socket (test point G), and listening to the sound output. When the C.W. AND MANUAL-MANUAL-A.V.C. switch is in the C.W. AND MANUAL position, an audible tone should be heard. Failure to obtain a tone is an indication of trouble in the circuit. Simple voltage and resistance measurements are then used to locate the cause of the failure.

LESSON PLAN No. 11

TIME ALLOTTED: ¾ HR.

SUBJECT

Beat-frequency (c-w) oscillator circuit.

OBJECTIVE

Analysis of the beat-frequency (c-w) oscillator circuit.

INTRODUCTION

When c-w code signals or unmodulated direction-finding signals are received, a special circuit must be used at the receiver to make them audible, since these signals themselves do not produce an audible tone which can be heard easily.

SUBJECT MATERIAL

1. Purpose of the circuit.
2. General description of operation.
3. Location of circuit.
4. Type of circuit and tube used.
5. Analysis of circuit operation.
    a. Breakdown into two sections.
    b. Analysis of oscillator section.
    c. Frequency-governing factors of oscillator section.
    d. Analysis of doubler section.
    e. Production of the beat note.

f. Switching the b.f.o. on and off.
6. Purpose of circuit components.
    a. Grid circuit.
    b. Screen-grid circuit.
    c. Plate circuit.
    d. Filament circuit.
7. Checking circuit operation.

CONCLUSIONS

The b-f-o circuit is important only to the proper reception of c-w signals, since is causes an audible tone to be produced whenever this type of signal is received. The circuit is unnecessary and undesirable in the reception of modulated signals, since it would cause an interfering tone to be present at the receiver output along with the desired sound.

ORAL QUIZ

1. What is the purpose of the b.f.o.?
2. How is the beat note (audible tone) produced?
3. How is the pitch of the tone controlled?
4. Where in the receiver is the b.f.o. located?
5. What is the reason for tuning the plate tank to twice the frequency of the grid tank?
6. What is the approximate frequency of the signal produced by the b.f.o.?
7. Can the frequency of the signal produced by the b.f.o. be varied by the operator?
8. In what positions of the C.W. AND MANUAL-MANUAL-A.V.C. switch is the b.f.o. in operation?
9. What function does the .001-uf. grid-coupling capacitor 276-2 perform?
10. What is the purpose of the 220-ohm resistor, 237-4, in the grid circuit of the tube?
11. Why are the two small capacitors, 267 and 246, used in series to feed the b-f-o signal into the detector circuit?
12. How can the operation of the b-f-o circuit be checked?

EXPERIMENT No. 7

TIME ALLOTTED: 2 HR.

SUBJECT

Automatic-volume-control and beat-frequency (c-w) oscillator circuits.

OBJECTIVE

To become familiar with the normal test indications of both the automatic-volume-control circuit and beat-frequency (c-w) oscillator circuit and also with the method used in checking their operation.

EQUIPMENT REQUIRED

1 Radio Receiver BC-639-A.
1 Rectifier Unit RA-42-B.
1 Power-supply cable equipped with two Jones connector sockets.
1 R-f signal generator (same as used in Experiment No. 3.)
1 Headset.

INSTRUCTIONS

After removing the receiver from the dust cover, connect it to the power supply, using the power-supply cable equipped with the two Jones connector sockets. Insert the headset plug into the MONITOR jack on the receiver front panel. Connect the power supply to the power source, and operate the POWER ON switch to on. (Do not apply power to the receiver unless a load is connected across its output.) Also connect the r-f signal generator to the power source and operate its POWER switch to ON. Allow both the receiver and the signal generator to warm-up for several minutes before continuing with the procedure. Do not change the position of the operating controls on either the receiver or the test equipment unless directed to do so. Make only tests outlined.

PROCEDURE

1. Set the operating controls on the r-f signal generator to the following positions:
    Set POWER switch to ON.
    Set MODULATION switch to INTERNAL.
    Set generator output frequency to 145 mc.
    Set r-f CARRIER to proper level.
    Set MODULATION control to 30%.
    Set r-f OUTPUT control to 50 microvolts.
2. Set the operating controls on the receiver to the following positions:

CONTROL	POSITION
ATTENUATION switch	0 DB
C. W. TONE CONTROL	Center line
R. F. GAIN INCREASE	Maximum clockwise
C. W. AND MANUAL-MANUAL-A. V.-C. switch	A. V. C.
AUDIO GAIN INCREASE	Maximum clockwise
Tuning control	To position where MEGACYCLES dial indicates 145 mc.
THRESHOLD SENSITIVITY control	To position where TUNING METER indicates 5 ma.

3. To determine whether the a-v-c circuit is operating, proceed as follows:
    a. Connect the output of the signal generator to the antenna-input receptacle of the receiver (test point G).
    b. A loud, clear tone should be heard in the headset.
    c. Gradually increase the OUTPUT control setting on the signal generator to maximum.
    d. The amplitude of the tone heard in the headset should remain fairly constant as the signal-

generator OUTPUT control setting is increased, and the indication on the receiver TUNING METER should gradually decrease.

4. To determine the effect which a change in position of the C.W. AND MANUAL-MANUAL-A.V.C. switch has upon the control action of the a-v-c circuit, proceed as follows:

a. Adjust the tuning control on the signal generator for minimum indication on the receiver TUNING METER.

b. Adjust the signal-generator OUTPUT control for a receiver TUNING METER indication of 3.2 ma., and note the intensity of the sound in the headset.

c. Set the C.W. AND MANUAL-MANUAL-A.V.C. switch to MANUAL. Note the effect which a change in position of the switch has upon the a-v-c action, as indicated by the change in TUNING METER indication and by the change in intensity of the sound in the headset.

5. To determine whether the a-v-c circuit is operating properly, proceed as follows:

a. Set the signal-generator OUTPUT control to the positions listed in the following chart, and record the corresponding receiver TUNING METER indications:

OUTPUT CONTROL SETTING	TUNING METER INDICATION
10 microvolts	
100 microvolts	
1 millivolt	
10 millivolts	

b. Compare the TUNING METER indications recorded above with those of a normally operating a-v-c circuit, listed in the following chart.

SIGNAL INPUT	TUNING METER INDICATION
10 microvolts	5 ma.
100 microvolts	4.8 ma.
1 millivolt	3.2 ma.
10 millivolts	2.0 ma.

6. To determine whether the beat-frequency (c-w) oscillator is operating, proceed as follows:

a. Adjust the signal-generator OUTPUT control to a position just high enough for normal volume in the headset.

b. Set the MODULATION control on the signal generator to OFF.

c. Set the C.W. AND MANUAL-MANUAL-A.V.C. switch on the receiver to C.W. AND MANUAL.

d. Slowly adjust the C.W. TONE CONTROL away from its center-line setting, first in a clockwise direction and then in a counterclockwise direction.

e. A clear tone whose pitch varies with the rotation of the control should be heard in the headset.

7. To determine the effect of the C.W. AND MANUAL-MANUAL-A.V.C. switch upon the operation of the beat-frequency (c-w) oscillator, proceed as follows:

a. Set the C.W. TONE CONTROL to the position where a tone of approximately 1000 cycles is heard in the headset.

b. Set the C.W. AND MANUAL-MANUAL-A.V.C. switch first to the MANUAL position and then to the A.V.C. position. Observe the effect of the switch upon the tone in the headset. Note that in both positions of the switch the C.W. TONE CONTROL is inoperative.

8. To determine the effect of improper tuning of the beat-frequency (c-w) oscillator circuit upon the tone which is produced in the headset, proceed as follows:

a. Set the C.W. AND MANUAL-MANUAL-A.V.C. switch to C.W. AND MANUAL.

b. Set the C.W. TONE CONTROL to the center-line position.

c. Adjust the signal-generator tuning control for zero beat in the headset.

d. Detune the beat-frequency (c-w) oscillator circuit by turning the adjustment on coil assembly 272 in a counterclockwise direction. Note the effect of the detuning upon the b-f-o circuit, as indicated by the sound in the headset.

e. Set the adjustment on coil assembly 272 to the point where a tone is just heard in the headset.

f. Rotate the C.W. TONE CONTROL from minimum to maximum, and note the effect of the detuning upon the operation of this control.

g. Reset the C.W. TONE CONTROL to the center-line position.

h. Retune the adjustment on coil assembly 272 for zero beat.

i. Adjust the C.W. TONE CONTROL to the position where a tone of approximately 1000 cycles is heard in the headset.

j. Detune output tank 266 of the beat-frequency (c-w) oscillator by turning its iron-core adjustment in a counterclockwise direction. Note the effect of the detuning upon the tone in the headset.

k. Retune output tank 266 by turning its iron-core adjustment in a clockwise direction for maximum sound in the headset. Then advance the adjustment one turn clockwise.

l. Disconnect the signal generator from the receiver.

9. Using the multimeter as a voltmeter, measure the voltages between the tube socket terminals of the beat-frequency (c-w) oscillator and the chassis. Record the voltage readings in the following chart.

PIN No.	SETTING OF C. W. AND MANUAL-MANUAL-A. V. C. SWITCH	VOLTAGE
4	C. W. AND MANUAL	
6	C. W. AND MANUAL	
8	C. W. AND MANUAL	
4	MANUAL	
6	MANUAL	
8	MANUAL	
6	A. V. C.	
8	A. V. C.	

10. Operate the POWER ON switch on the power supply to off. Using the multimeter as an ohmmeter, measure and record the resistance between the receiver chassis and the points indicated in the following chart.

TUBE SOCKET	PIN No.	SETTING OF C. W. AND MANUAL-MANUAL-A. V. C. SWITCH	RESISTANCE IN OHMS	CIRCUIT COMPONENTS MEASURED
Detector-a.v.c.-1st audio amplifier	3	A. V. C.		
	5	A. V. C.		
	5	MANUAL		
	3	C. W. AND MANUAL		
Beat-frequency (c-w) oscillator	4	C. W. AND MANUAL		
	6	C. W. AND MANUAL		
	8	C. W. AND MANUAL		
	6	MANUAL		
	8	MANUAL		

11. After completing this portion of the experiment, request the instructor to put trouble into the automatic-volume control circuit, and into the beat-frequency (c-w) oscillator circuit. Using the tests given in the preceding portion of this experiment, locate and correct the trouble.

CONCLUSIONS

1. What two receiver indications may be used to determine whether the a-v-c circuit is functioning?

2. How is the over-all operation of the a-v-c circuit checked?

3. In which positions of the C.W. AND MANUAL-MANUAL-A.V.C. switch is the a-v-c circuit in use?

4. Why does a strong signal cause the TUNING METER indication to drop when the a-v-c circuit is in use?

5. How is the b-f-o circuit switched on?

6. What is the purpose of the C.W. TONE CONTROL?

7. What effect does improper tuning of the b-f-o circuit have upon the operation of the C.W. TONE CONTROL?

8. What effect would a shorted oscillator-plate by-pass capacitor (230-19) have upon the plate and screen voltages of the b-f-o tube?

9. What test procedure may be used to locate a defective screen dropping resistor in the b-f-o circuit?

10. Does the absence of voltage on the grid (pin 4) of the b-f-o tube indicate an operative or an inoperative b-f-o circuit?

LECTURE No. 12

CIRCUIT ANALYSIS OF AUDIO-FREQUENCY AMPLIFIER

The audio-frequency amplifier circuit in the BC-639-A is used to amplify the relatively weak audio signal provided by the detector circuit, and to furnish the necessary audio power for operating headphones and other reproducing devices. This circuit is shown in block form in figure 15 and in schematic form in figure 24.

The audio-frequency amplifier circuit is a two-stage resistance-coupled amplifier, which utilizes the triode portion of the detector-a.v.c.-1st audio amplifier tube, type VT-103 (6SQ7), as the 1st audio-amplifier stage, and a pentode power-amplifier tube, VT-152 (6K6GT), as the 2nd audio-amplifier or output stage. The components of the 1st stage are located at the right rear of the receiver chassis and those of the 2nd stage, in the center of the chassis (see figures 9, 10, and 11).

The audio-frequency amplifier has a frequency-response characteristic which is essentially flat from 600 to 3000 cycles, and is 10 db down at both 200 and 5000 cycles. The amplifier is designed to operate into a 600-ohm load impedance, but satisfactory operation may be secured when operating into any load impedance between 200 and 20,000 ohms. Output regulation is such that the use of load impedances between 200 and 20,000 ohms causes a change in output which is no greater than —6 db to + 6 db as compared to the 600-ohm reference level. The amplifier is capable of delivering one watt of audio power into a 600-ohm load, with less than 15% distortion.

When the audio signal from the detector circuit is introduced into the two-stage audio-amplifier circuit through the .0068-uf. coupling capacitor, 230-17, the 1-megohm AUDIO GAIN INCREASE control, 251, acting as a volume control, regulates the amount of signal which is applied to the grid of the 1st audio-amplifier stage. Amplification in this stage increases the strength of the audio signal, which is then fed into the 2nd stage through an attenuation network

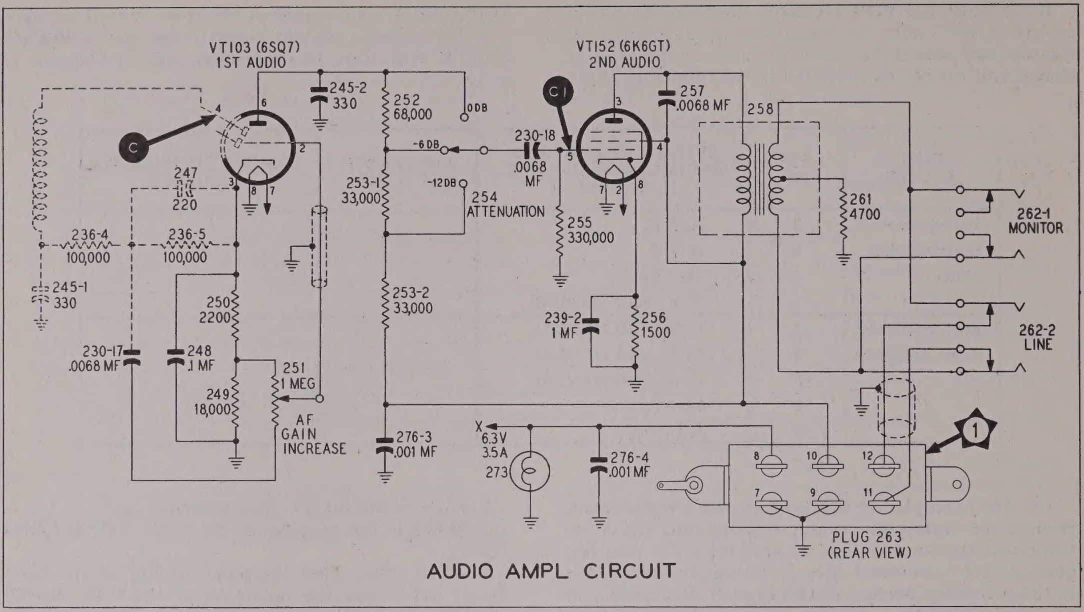


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Figure 24. Schematic Diagram of Audio-Amplifier Circuit

and the .0068-uf. coupling capacitor, 230-18. The amount by which the signal is attenuated before it reaches the 2nd audio-amplifier stage is determined by the setting of the three-position ATTENUATION switch, 254, marked —12 DB, —6 DB, and 0 DB. Although the position of this switch determines the maximum audio output of the receiver, it is normally left in the 0 DB position unless specific applications, which require a lower output signal, make it necessary to set the switch to one of the other positions. The signal that is introduced into the 2nd audio-amplifier stage is amplified and then fed through the output transformer, 258, to the two output terminals of the receiver at power-supply plug 263, and to both the MONITOR and LINE jacks. The output characteristics of the amplifier make it especially suitable for operation directly into a telephone line system, thus making it possible to monitor the signal at points other than where the receiver is located. The telephone-line connections are made to the output terminals (terminals 11 and 12) on the power-supply plug, 263. Both the MONITOR and LINE jacks are used for monitoring purposes at the receiver.

The purpose of the coupling capacitor, 230-17, as previously explained, is not only to transfer the audio-frequency signal from the detector load into the grid circuit of the 1st audio-amplifier stage, but also to prevent the negative d-c voltage which is developed across these resistors from being applied to the grid of the 1st audio-amplifier tube, where it would disrupt the operation of the stage. The audio signal which is transferred from the detector circuit into the 1st audio-amplifier stage is impressed across the 1-megohm AUDIO GAIN INCREASE control, 251, which acts as a volume control. This control not only determines the amount of signal voltage which reaches the grid of the tube but also functions as the grid resistor. Grid operating bias for the stage is provided by the 2200-ohm resistor, 250, which is by-passed by the .1-uf. capacitor, 248, in the cathode circuit of the tube. The 2200-ohm resistor, 250, in conjunction with the 18,000-ohm resistor, 249, provides the cathode of the tube with a d-c path to ground. By-pass capacitor 248 keeps the cathode of the tube at both r-f and a-f ground potential and also maintains the bias voltage at a stable value. Operating voltage for the plate is obtained from the high-voltage bus, through the two 33,000-ohm resistors, 253-1 and 253-2, and through the 68,000-ohm resistor, 252. These resistors serve as the plate load for the stage, and are connected to a three-position switch (ATTENUATION control 254), to form an audio attenuator, which is used to regulate the audio-output level of the 1st audio-amplifier stage. The 330-uuf. capacitor, 245-2, in the plate circuit of this stage provides a low-impedance path to ground for any r-f voltage which may have leaked through from the detector circuit. The long leads which are used to connect both the AUDIO GAIN INCREASE control and the ATTENUATION control are shielded, in order to minimize circuit interaction and the introduction of hum and noise into the amplifier circuit, due to stray coupling. The .0068-uf. capacitor, 230-18, couples the 1st audio-amplifier stage to the 2nd stage to provide a path for the signal voltage and, in addition, prevents the d-c voltage in the plate circuit of the 1st stage from being applied to the grid circuit of the 2nd stage. The 330,000-ohm resistor, 255, in the grid circuit of the 2nd audio amplifier tube functions as the grid, or input, load resistor of the stage, and also provides the grid of the tube with d-c return path to ground. Grid operating bias for the stage is provided by the 15,000-ohm resistor, 256, which is by-passed by the .1-uf. capacitor, 239-2. The operating bias is purposely made higher than normal, in order to reduce the gain and power output of the stage and to prevent the plate of the tube from drawing more than 60 ma. of current. The .1-uf. capacitor, 239-2, keeps the cathode of this tube at a-f ground potential, and also maintains the bias voltage at a stable value.

The operating voltage for the screen grid is obtained directly from the high-voltage bus, which is kept at r-f ground potential by the .001-uf. capacitor, 276-4.

The operating voltage for the plate is also obtained from the high-voltage bus through the primary of the output transformer, 258. The .0068-uf. capacitor, 257, is used to peak the frequency response of the output transformer, 258, at 1000 cycles, which is approximately the center of the speech-frequency range. The output transformer is used to match the plate impedance of the amplifier tube to the output, or load, impedance. This transformer has an electrostatic shield between its windings and provides a balanced type of output, since the ground connection is made to the center tap of the output winding through the 4700-ohm resistor, 261. The output is suitable for direct connection to a telephone-line circuit, inasmuch as the output impedance of 600 ohms was selected to satisfy this requirement. Telephone-line connections may be made to terminals 11 and 12 of the power-supply plug, 263. Both the LINE and MONITOR jacks may be used for monitoring purposes at the receiver. However, the MONITOR jack is used oftener than the LINE jack for this purpose, since the LINE jack is a line-lifting jack. The plugging of a headset into the LINE jack, 262-2, disconnects the telephone line from the output of the receiver, and allows the signal to be heard only in the headset. The plugging of a headset into the MONITOR jack, 262-1, has no effect upon the telephone-line connections to the output of the receiver, since the MONITOR jack is not a line-lifting jack and is connected in parallel with the telephone line. The use of this jack permits the signal to be monitored without disturbing the normal operation of the receiver into the telephone-line system. The .001-uf. filament by-pass capacitor, 276-4, keeps the filament-supply bus at r-f ground potential.

Failure of any component within the audio amplifier circuit affects the over-all operation of the receiver. The operation of the amplifier circuit may be checked by introducing a 1000-cycle audio signal of known amplitude into the circuit at test point C (see figure 21) and measuring the strength of the signal at the output of the circuit, which in this case is also the output of the receiver. The signal introduced at test point C will produce a specific output indication only when the audio-amplifier circuit is operating normally. Failure to obtain proper indication points to trouble in one of the two stages of the circuit, and indicates a need for further checks which will isolate the stage at fault. By introducing a 1000-cycle audio signal of known amplitude into the 2nd audio-amplifier stage and then into the 1st audio-amplifier stage at test points CI and D, respectively, an indication of the condition of these stages can be obtained. When the defective stage is found, simple voltage and resistance measurements are used to locate the cause of the failure.

LESSON PLAN No. 12

TIME ALLOTTED: ¾ HR.

SUBJECT

Audio-amplifier circuit.

OBJECTIVE

To analyze the audio-amplifier circuit.

INTRODUCTION

Since the audio signal provided by the detector circuit is usually rather weak, some means must be used to increase the power of the audio signal so that satisfactory volume is obtained even when receiving very weak signals.

SUBJECT MATERIAL

1. Purpose of the circuit.
2. Circuit location.
3. Type of circuit and tubes used.
4. Characteristics of the amplifier.
    a. Frequency response.
    b. Load impedance.
    c. Output regulation.
    d. Power output.
5. Analysis of circuit operation.
6. Source of operating voltages, and purpose of circuit components of the 1st stage.
    a. Input-circuit components.
    b. Grid bias.
    c. Cathode-circuit components.
    d. Plate voltage.
    e. Plate-circuit components.
7. Source of operating voltages, and purpose of circuit components of the 2nd stage.
    a. Input-circuit components.
    b. Grid bias.
    c. Cathode-circuit voltage.
    d. Screen-grid voltage.
    e. Plate voltage.
    f. Plate-circuit components.
8. Purpose of various output jacks and terminals.
9. Use of test points in checking the operation of the circuit.

CONCLUSIONS

The audio-amplifier circuit used in the BC-639-A provides sufficient audio power to operate the various reproducing devices which may be used with the receiver, including the telephone-line system to which it is normally connected.

ORAL QUIZ

1. What is the purpose of the audio-frequency amplifier?
2. How many stages does the audio-frequency amplifier have?
3. What tube is used in each stage?
4. What is the frequency response of the amplifier?
5. Into what load impedance does the amplifier operate best? What is its power output?

6. How much does the power output change, from the reference level obtained by operating the amplifier into a 600-ohm load, when the amplifier is operated into a load impedance of 200 ohms? 20,000 ohms?

7. What means are provided for controlling the amplitude of the audio output?

8. Where are the output terminals for the telephone-line connections located?

9. How is grid bias for the 1st audio-amplifier stage obtained?

10. What are the functions of coupling capacitors 230-17 and 230-18?

11. Why is the bias voltage on the 2nd stage higher than that normally required for proper operation of this type of tube?

12. What is the purpose of capacitor 257, connected across the primary of the output transformer?

13. What is the purpose of the MONITOR and LINE jacks?

14. Why is the MONITOR jack generally used instead of the LINE jack for monitoring purposes?

15. How can the operation of the audio amplifier be checked?

EXPERIMENT No. 8

TIME ALLOTTED: 1½ HR.

SUBJECT

Audio-frequency amplifier circuit.

OBJECTIVE

To become familiar with the normal test indications of the audio-frequency amplifier circuit, and with the method used to check its operation.

EQUIPMENT REQUIRED

1 Radio Receiver BC-639-A.
1 Rectifier Unit RA-42-B.
1 Power-supply cable equipped with two Jones connector sockets.
1 Multimeter (20,000-ohms-per-volt sensitivity).
1 Audio-frequency signal generator.
1 Headset.
1 600-ohm, two-watt carbon resistor.
1 200-ohm two-watt carbon resistor.
1 20,000-ohm, two-watt carbon resistor.

INSTRUCTIONS

After removing the receiver from the dust cover, connect it to the power supply, using the power-supply cable equipped with the two Jones connector sockets. Insert the headset plug into the MONITOR jack on the receiver front panel. Connect the power supply to the power source. Do not apply power to the receiver unless a load is connected across its output. Operate the POWER ON switch to on. Also connect the audio-frequency signal generator to the power source. Allow both the receiver and the signal generator to warm up for several minutes before continuing with the procedure. Do not change the position of any of the operating controls on either the receiver or the test equipment unless directed to do so. Make only the tests outlined.

PROCEDURE

1. To determine whether the over-all audio-frequency amplifier is operating, proceed as follows:
   a. Set the ATTENUATION control to 0 DB position, and the AUDIO GAIN INCREASE control to maximum (fully clockwise).
   b. On the audio signal generator set the frequency control to 1000 cycles, and the output control for approximately half of the maximum possible output.
   c. Connect the grounded output lead of the signal generator to the receiver chassis.
   d. Connect the ungrounded output lead of the signal generator through a .1-uf. capacitor to pin 4 (test point C) of the detector-a.v.c.-1st audio amplifier tube (6SQ7).
   e. A loud, clear tone should be heard in the headset.
2. To determine whether each of the audio-frequency amplifier stages is operating, proceed as follows:
   a. Connect the ungrounded output lead of the signal generator to pin 5 (test point C1) of the 2nd audio-amplifier tube (6K6GT).
   b. Increase the signal-generator output.
   c. A loud, clear tone should be heard in the headset.
   d. Decrease the signal-generator output until the volume of the tone in the headset is very low.
   e. Disconnect the signal-generator output from test point C1 and connect it to test point C (pin 4 of the 6SQ7 tube).
   f. A loud, clear tone should again be heard in the headset.
3. To determine the effect of the AUDIO GAIN INCREASE control, the ATTENUATION control, the LINE jack, and the MONITOR jack upon the output of the audio-frequency amplifier circuit, proceed as follows:
   a. Connect the multimeter (30-volt range) or an output meter, in parallel with a 600-ohm, two-watt resistor, across terminals 11 and 12 of the receiver power supply plug, 263.
   b. Remove the headset plug from the MONITOR jack on the receiver front panel.
   c. Connect the ungrounded output lead of the signal generator through a .1-uf. capacitor to test point C (pin 4 of the 6SQ7 tube).
   d. Adjust the signal-generator output control for a receiver-output indication of 2.5 volts.
   e. Slowly vary the AUDIO GAIN INCREASE control from maximum to minimum; note the effect of the control upon the output of the audio-frequency amplifier as indicated by the output-meter reading.

f. Reset the AUDIO GAIN INCREASE control to maximum.

g. Set the ATTENUATION control to the —6 DB position and then to the —12 DB position. Note the effect of this control upon the output of the audio-frequency amplifier as indicated by the output-meter reading.

h. Reset the ATTENUATION control to the 0 DB position.

i. Insert the headphones plug into the LINE jack and then into the MONITOR jack on the receiver front panel. Note the effect of the use of these jacks, for monitoring purposes, upon the output of the amplifier circuit as indicated by the output-meter reading.

4. To determine the effect of a change in output-load impedance upon the power output of the receiver, proceed as follows:

a. Adjust the signal-generator frequency control to 1000 cycles.

b. Remove the headset plug from the MONITOR jack.

c. Record the output-meter indication.

d. Operate the POWER ON switch on the power supply to off.

e. Disconnect the 600-ohm, two-watt resistor from the output terminals on the receiver (terminals 11 and 12 of power-supply plug 263), and connect a 20,000-ohm, two-watt resistor in its place.

f. Operate the POWER ON switch on the power supply to on.

g. Record the output-meter indication.

h. Operate the POWER ON switch on the power supply to off.

i. Disconnect the 20,000-ohm, two-watt resistor from the output terminals of the receiver (terminals 11 and 12 of power-supply plug 263), and connect a 200-ohm, two-watt resistor in its place.

j. Operate the POWER ON switch on the power supply to on.

k. Record the output-meter indication.

l. Compare the indications recorded in steps 4.g. and 4.k. with the indication recorded in step 4.c. Note the effect which the different output-load impedances have upon the power output of the audio-amplifier circuit.

TUBE SOCKET	PIN No.	RESISTANCE IN OHMS	CIRCUIT COMPONENTS MEASURED
1st audio amplifier	2		
	3		
	6		
	3		
2nd audio amplifier	4		
	5		
	8		

5. Disconnect the signal generator and the output meter from the receiver. Do not disconnect the 200-ohm resistor from terminals 11 and 12.

6. Using the multimeter as a voltmeter, measure the voltages between the tube-socket terminals and the chassis. Record the voltage readings in the following chart.

TUBE SOCKET	PIN No.	VOLTAGE
1st audio amplifier	3	
	2	
	6	
2nd audio amplifier	3	
	4	
	5	
	8	

7. Operate the POWER ON switch on the power supply to off. Using the multimeter as an ohmmeter, measure and record the resistance between the receiver chassis and the points indicated in the following chart.

8. After completing this portion of the experiment, request the instructor to put trouble into the audio-amplifier circuit. Using the tests given in the preceding portion of this experiment, locate and correct the trouble.

CONCLUSIONS

1. What test is used to check the operation of the over-all audio-frequency amplifier circuit?

2. How can the operation of the 2nd audio-amplifier stage be checked?

3. If the 1st audio-amplifier stage were inoperative, what test procedure would be followed in locating the defective stage?

4. What effect does the ATTENUATION control have upon the receiver output?

5. Give the procedure for locating a defective r-f plate by-pass capacitor in the 1st audio-amplifier stage.

6. Give the procedure for locating a defective output transformer in the 2nd audio-amplifier stage.

LECTURE No. 13

CIRCUIT ANALYSIS OF POWER SUPPLY

The power requirements of Radio Receiver BC-639-A are: 6.3 volts, a.c. or d.c., at 3.5 amperes, and 210 volts, d.c., at 60 milliamperes. The 6.3 volts is required for lighting the tube filaments, and the 210 volts is required for plate and screen-voltage supply. These voltages are obtained from an external power source, since the receiver has no built-in power supply of its own.

The power for operating Radio Receiver BC-639-A is generally furnished by any one of three different power supplies:

1. Rectifier Unit RA-42-A.
2. Rectifier Unit RA 42-B.
3. Dynamotor Unit PE-100-A.

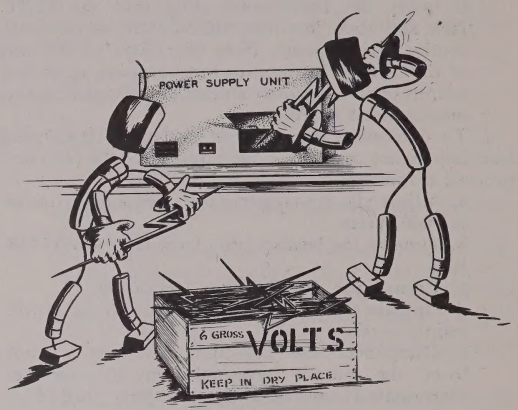
Rectifier Unit RA-42-B is the only one of these units that will be discussed, since both Rectifier Units RA-42-A and RA-42-B are similar and since Dynamotor Unit PE-100-A is of a conventional type which requires no explanation.

Rectifier Unit RA-42-B consists of power-supply circuits which are designed to furnish all of the power needed for operating Radio Receiver BC-639-A. Rectifier Unit RA-42-B may be operated from either a 110-volt power source at voltages ranging between 90 and 140 volts or from a 220-volt power source at voltages ranging from 200 to 250 volts, by simply changing the power-input connections inside of the unit. The output voltages of the circuit are available at a recessed plug at the rear of the unit.

The power-supply circuit is shown in block form in figure 15 and in schematic form in figure 25. The schematic diagram shows the circuit hookup for operation from a 110-volt power source. For operation from a 220-volt power source, the power-input connection to the primary of the power transformer, 350, must be changed from the 110-volt tap (tap 8) to the 220-volt tap (tap 1). The POWER ON switch, 356, controls the application of power to the circuit in both hookups.

In accomplishing its purpose the power supply converts the high a-c voltage obtained from the external power source into both a low a-c voltage for lighting the tube filaments of the receiver and a high d-c voltage for satisfying the plate and screen-voltage requirements of the receiver. The section of the circuit which supplies the d-c voltage makes use of rectifier tube VT-206A (5V4G) in a full-wave rectifier circuit.

When the POWER ON switch is thrown to the POWER ON position, power is applied to the primary of power transformer 350 through the two A. C. SUPPLY FUSES, 361-1 and 361-2, and the SUPPLY VOLTAGE control, 355. This applied power causes an a-c voltage to be induced into each secondary winding of the transformer, The magnitude of the voltage induced into each winding depends upon the ratio of the turns in the primary to the turns in each secondary winding. These ratios may be changed and thus the induced voltages may also be changed by adjusting the SUPPLY VOLTAGE control, 355. Each terminal of this six-position, switch-type control is connected to a different tap on the primary of the power transformer. Changing the setting of the control changes the number of turns which are actually used in the primary. This control therefore acts as a power-source voltage-compensating control, since by changing the turns ratios of the primary and secondary windings, the control makes it possible to keep the output voltages of the circuit at the required value, regardless of whether the unit is operating from a 90-volt or 140-volt power source (110-volt hookup) or from a 200-volt or 250-volt power source (220-volt hookup).



The transformer has three secondary windings, two of which are low-voltage windings (6.3 volts and 5 volts) and the third is a high-voltage center-tapped winding (350 volts).

The 6.3-volt winding is connected directly to terminals 7 and 8 on the power-output plug, 357, and is used to supply the filament power of the receiver as well as the power necessary to light the indicator jewel light on the front panel of the rectifier unit.

The other two windings are used in the rectifier circuit which supplies the d-c voltage for the receiver. The low-voltage (5-volt) winding is connected to the filament terminals of the rectifier tube and the high-voltage (350-volt) center-tapped winding is connected to the plate terminals. The center tap on the high-voltage winding is the rectifier return, and it is connected directly to ground and to terminal 9 on the power-output plug through the 125 MA. D. C. FUSE, 361-3.

The high a-c voltage applied to the plates of the VT-206A (5V4G) rectifier tube is converted, through rectifier action, into pulses of d-c voltage, which are present at the filament terminal of the rectifier tube. These pulses of d-c voltage are fed into a choke-input type of filter network, which through filter action

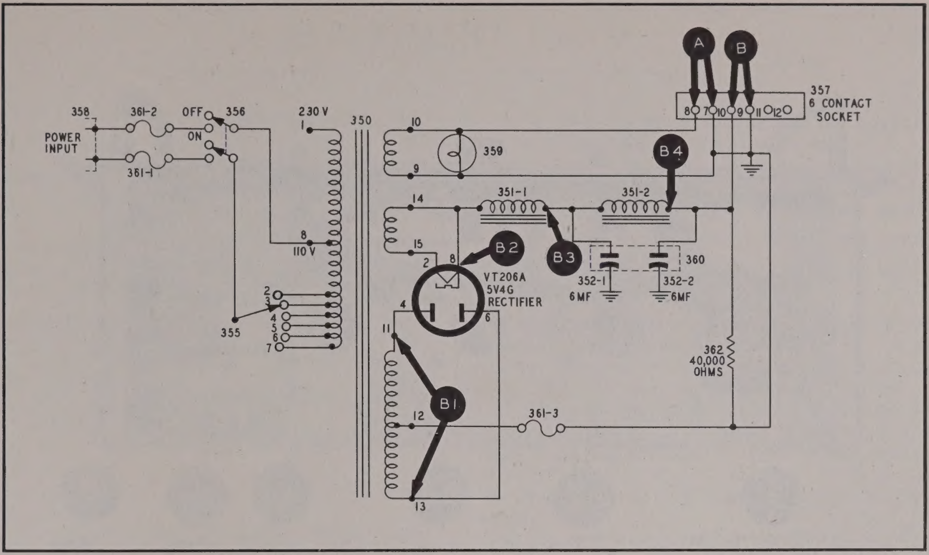


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Figure 25. Schematic Diagram of Power-Supply Circuit

smoothes out the pulses, and provides a constant, hum-free output voltage. The output of the filter network is connected to a 40,000-ohm bleeder resistor, 362, and to terminal 10 on the power-output plug, 357. Terminal 10 is the positive 210-volt output terminal of the power supply and terminal 9 is the negative.

The two A. C. FUSES, 361-1 and 361-2, in the primary circuit of the power transformer protect the power-supply circuit from damage due to overloads and improper power-source voltages. The 125 MA. D. C. FUSE, 361-3, which is in series with the center tap of the high-voltage secondary winding of the transformer, protects the rectifier circuit from damage due to overloads etc. All three fuses are mounted on the front panel to facilitate replacement.

The indicator jewel light is used to indicate to the operator whether the rectifier unit is turned on or off. The filter network in the rectifier circuit is a two-section choke-input type of filter. The first section consists of choke coil 351-1 and capacitor 352-1, and the second section consists of choke coil 351-2 and capacitor 352-2. This filter network effectively removes the undesirable components from the rectified voltage. Although the output voltage of the B voltage supply circuit is not as high as could be obtained with a capacitor-input type of filter network, the voltage regulation is considerably better. A power supply with good voltage regulation is very desirable, since the operational stability of the receiver depends, in part, upon whether a constant d-c voltage is provided by the power supply, under varying load conditions. The 40,000-ohm bleeder resistor, 362, connected across the output of the B voltage supply circuit, is used to discharge the filter network when the unit is switched on and then off under no-load conditions, thus eliminating the possibility of shock due to the filter capacitor's holding a charge.

Failure of any component within the power-supply circuit affects the over-all operation of the receiver. The operation of the power-supply circuit may be checked by measuring the voltages at the power-output plug, 357—first at test point A and then at test point B (see figure 26). The measurement at test point A checks the primary circuit and the 6.3-volt secondary winding of the power transformer. The measurement at test point B checks the over-all condition of the B voltage supply circuit. Failure to obtain the proper voltage indication at test point B points to trouble in the B voltage supply circuit, and indicates the need for additional checks. Checks made progressively at test points B1, B2, B3, and B4 will isolate and possibly locate the cause of B voltage supply circuit failure. Simple resistance measurements may then be used to check the suspected parts.

LESSON PLAN No. 13

TIME ALLOTTED: 1/3 HR.

SUBJECT

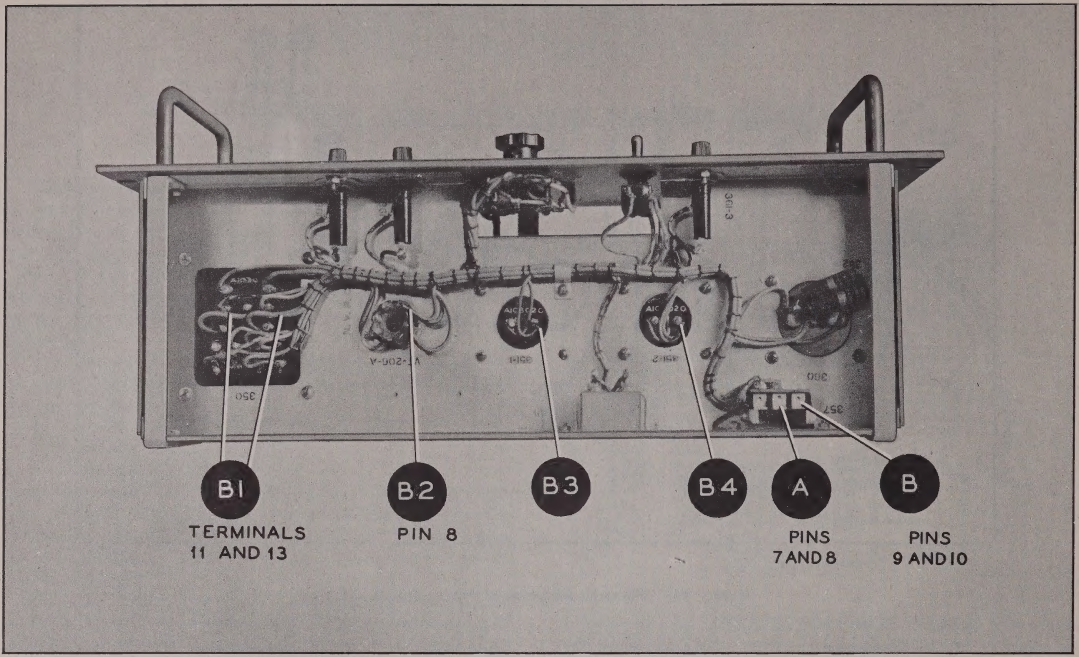
Power-supply circuit.

OBJECTIVE

To analyze the power-supply circuit.

INTRODUCTION

In order for any electronic device to function it must be furnished with the proper operating voltages.



229B

Figure 26. Rectifier Unit RA-42-B, Bottom View, Showing Locations of Test Points

SUBJECT MATERIAL

1. Power requirements of the receiver.
2. Types of power units used.
3. Reason for limiting discussion to Rectifier Unit RA-42-B.
4. Power-source voltages required for Rectifier Unit RA-42-B.
5. Changes necessary for shifting operation from a 110-volt power source to a 220-volt power source.
6. General description of operation.
7. Type of rectifier circuit and tube used.
8. Analysis of circuit operation.
   a. Application of power to the primary of the power transformer.
   b. Factors governing the magnitude of the secondary voltages.
   c. Purpose of the SUPPLY VOLTAGE control.
   d. Purpose of the various transformer secondary windings.
   e. Explanation of the B voltage supply circuit operation.
9. Purpose of circuit components.
   a. Fuses.
   b. Indicator jewel light.
   c. Filter network.
   d. Bleeder resistor.
10. Use of test points for checking the operation of the circuit.

CONCLUSIONS

When the voltages measured at the test points in the power-supply circuit are normal, the power-supply circuit can be assumed to be free of trouble and operating normally.

ORAL QUIZ

1. What are the power requirements of the receiver?

2. Does the receiver have a built-in power supply of its own? How does it obtain its operating power?

3. On what power-source voltages does Rectifier Unit RA-42-B operate?

4. What changes in wiring must be made to shift operation from a 110-volt power source to a 220-volt power source?

5. What type of rectifier circuit is used in the rectifier unit?

6. What is the purpose of the SUPPLY VOLTAGE control?

7. What is the purpose of the two A. C. FUSES? The 125 MA. D. C. FUSE?

8. What is the principal advantage of a choke-input type of filter network?

9. What is the purpose of the bleeder resistor connected across the output of the B voltage supply circuit?

10. How is the operation of the B voltage supply circuit checked?

11. What voltage is present at test point Ⓐ in a unit which is operating normally? At test point Ⓑ ?

EXPERIMENT No. 9

TIME ALLOTTED: 1½ HR.

SUBJECT

Power-supply circuit.

OBJECTIVE

To become familiar with the normal test indications of the power-supply circuit, and with the method used in checking its operation.

EQUIPMENT REQUIRED

1 Radio Receiver BC-639-A.
1 Rectifier Unit RA-42-B.
1 Power-supply cable equipped with two Jones connector sockets.
1 Multimeter (20,000-ohms-per-volt sensitivity).
1 Headset.

INSTRUCTIONS

Remove the receiver and the power supply from their dust covers. Interconnect the two units, using the cable equipped with two Jones connector sockets. Insert the headphones plug into the MONITOR jack on the receiver front panel. Connect the power supply to the power source. Do not apply power to the receiver unless a load is connected to its output. Operate the POWER ON switch on the power supply to on. Allow both units to warm up for a few minutes before proceeding. Make only the tests outlined.

PROCEDURE

1. To determine whether the power-supply circuit is providing the receiver with the proper operating voltages, make checks at test point 1, as follows:

a. Using the multimeter as an a-c voltmeter (30-volt range), check the filament supply by connecting the test leads between terminal 8 of the receiver power-supply plug (263), and the chassis.
b. The voltmeter should indicate approximately 6.3 volts. Record the reading obtained.
c. Using the multimeter as a d-c voltmeter (500-volt range), check the B voltage supply by connecting the positive lead of the voltmeter to terminal 10 of the receiver power-supply plug 263, and the negative lead to the chassis.

CAUTION: A high d-c potential is normally present between terminal 10 and the chassis.

d. The voltmeter should indicate approximately 210 volts. Record the reading obtained.

2. To determine whether the power-supply unit is operating, proceed as follows:

a. Operate the POWER ON switch to off.
b. Disconnect the power-supply unit from the receiver by removing the interconnecting cable.
c. Operate the POWER ON switch to on.
d. Using the multimeter as an a-c voltmeter (30-volt range), check the filament-supply section of the power supply by connecting the test leads between terminal 8 of power-output plug 357 (test point A), and the chassis.
e. The voltmeter should indicate approximately 6.3 volts. Record the reading obtained.
f. Using the multimeter as a d-c voltmeter (5000-volt range), check the B voltage supply section of the power supply by connecting the positive lead of the voltmeter to terminal 10 (test point B) of the power-output plug (357), and the negative lead to the chassis.

CAUTION: High voltage is normally present between terminal 10 and the chassis.

g. The voltmeter should indicate approximately 350 volts. Record the reading obtained.

3. Compare the voltage readings obtained with the receiver connected, as recorded in steps 1. b. and 1. d., with those obtained with the receiver disconnected, as recorded in steps 2. e. and 2. g. Note the effect of the receiver upon the output voltages of the power supply.

4. To determine whether the power transformer is providing the rectifier circuit with high a-c voltage, proceed as follows:

a. Using the multimeter as an a-c voltmeter (1000-volt range), connect the test leads between terminals 11 and 13 of power transformer 350 (test point B1).

CAUTION: A high a-c voltage is normally present at test point B1.

b. The voltmeter should indicate approximately 680 volts.

5. To determine whether the rectifier circuit is operating, proceed as follows:

a. Using the multimeter as a d-c voltmeter (500-volt range), connect the positive lead of the voltmeter to pin 8 of the rectifier tube (test point B2), and the negative lead to the chassis.

CAUTION: A high voltage is normally present at test point B2.

b. The voltmeter should indicate approximately 350 volts.

6. To determine whether the power-supply filter network is operating properly, proceed as follows:

a. Using the multimeter as a d-c voltmeter (500-volt range), connect the negative lead to the chassis; connect positive lead, first, to the output terminal of choke coil 351-1 (test point B3), and then to the output terminal of choke coil 351-2 (test point B4).

CAUTION: A high voltage is normally present at both test points.

b. The voltmeter should indicate approximately 350 volts at both test points.
c. Disconnect the positive lead of the voltmeter from test point B4, operate the POWER ON switch on the power-supply unit to off, and wait ½ minute.

d. Reconnect the positive lead of the voltmeter to test point B4 and observe the voltmeter indication at the instant of contact.

e. Correct operation of the bleeder resistor will be indicated by the absence of a voltage indication at the time of contact.

f. Reconnect the power-supply unit to the receiver, using the cable equipped with the two Jones connector sockets. Operate the POWER ON switch to on, and wait 2 minutes.

g. On the receiver, set the AUDIO GAIN INCREASE control to minimum and plug the headset into the MONITOR jack.

h. A normal condition of the filter network is indicated by the absence of a loud hum in the headset and normal test indications at test points B3 and B4 .

7. Operate the POWER ON switch on the power supply unit to off. Disconnect the power supply from the receiver by removing the interconnecting cables.

8. Using the multimeter as an ohmmeter, measure and record the resistance between the points indicated in the following chart.

9. After completing this portion of the experiment, request the instructor to put trouble into the power supply. Using the tests given in the preceding portion of this experiment, locate and correct the trouble.

CONCLUSIONS

1. What is the purpose of test point 1 ?

2. What test is generally used to determine whether the power-supply circuit is operating?

3. Is the voltage at test point B higher with the receiver connected to the power supply than it is with the receiver disconnected? Why?

4. Give a test procedure for locating a defective filter capacitor at the output of the filter network.

5. How can the operation of the bleeder resistor be checked?

6. If no voltage is measured at either test point A or B , what portion of the power-supply circuit should be checked first? How should this check be made?

LOCATION OF TEST POINT	TEST BETWEEN	RESISTANCE IN OHMS	CIRCUIT COMPONENTS MEASURED
POWER TRANSFORMER	Terminals 1 and 7		
	Terminals 1 and 8		
	Terminals 9 and 10		
	Terminals 14 and 15		
	Terminals 11 and 12		
	Terminals 12 and 13		
	Terminals 11 and 13		
	Terminal 11 and chassis		
	Terminal 12 and chassis		
	Terminal 13 and chassis		
Choke coil 351-1	Terminals		
Choke coil 351-2	Terminals		
Rectifier tube	Pin 8 and chassis		
Power-output plug 357	Terminal 10 and chassis		
	Terminal 8 and chassis		
Power-input plug 358	Terminals		

LECTURE No. 14

ALIGNMENT AND ADJUSTMENT

Alignment of the circuits of the BC-639-A and a repositioning of its adjustable components become necessary from time to time, because of the changes which occur in circuit constants and in the settings of adjustable components, due to humidity, vibration, etc. Often the need for alignment or adjustment is obvious; at other times the need is revealed only by testing.

When an over-all alignment is to be made, the following types of alignment and adjustment procedures are involved.

1. Alignment of the i-f amplifier circuit.

2. Alignment of the beat-frequency (c-w) oscillator circuit.

3. Adjustment of the tuning mechanism.

4. Alignment of the h-f oscillator, doubler, mixer, and r-f amplifier circuits.

5. Adjustment of the threshold sensitivity of the receiver.

These procedures will be discussed in the order in which they are normally performed in an over-all receiver alignment.

The following test instruments and tools are required for the proper performance of the alignment and adjustment procedures:

1. An accurately calibrated, internally modulated signal generator with a low-impedance output of approximately 70 ohms and a frequency range which includes the frequency of 12,000 kc. and the range of frequencies between 100 and 156 mc. It must also have an adjustable percentage of modulation and a calibrated OUTPUT attenuator.

2. An output meter or an a-c voltmeter, with a 30-volt range, which is capable of accurately measuring 1000-cycle a-c voltages.

3. A set of insulated aligning tools consisting of
   Insulated or plastic pliers.
   Plastic rod.
   Insulated screw driver.
   A headset.
   A tuning wand or its equivalent.

If the signal generator listed above is unavailable the following test instruments may be used instead.

1. An accurately calibrated, internally modulated r-f signal generator with a frequency range which includes 12,000 kc.

2. Frequency Meter BC-638-A with three crystals of the following frequencies:
   5555.555 kc.
   7222.222 kc.
   8666.666 kc.

Before the alignment is started, it is necessary to prepare both the receiver and the signal-generating instrument for use as follows:

The receiver is removed from its dust cover so that all the adjustments will be accessible.

A 600-ohm noninductive resistor is connected as an output load in parallel with the output meter or a-c voltmeter across the receiver output terminals. The receiver is connected to the power supply, and headset is plugged into the MONITOR jack on the receiver front panel. Then both the power supply and the signal-generating instrument are connected to the power source and the power is turned on. Both units should be allowed to warm up for about 15 minutes before alignment is started. Generally both units will have reached stable operating temperatures in this period of time. It is considered good practice to make certain that a load is always connected across the receiver output whenever power is applied.

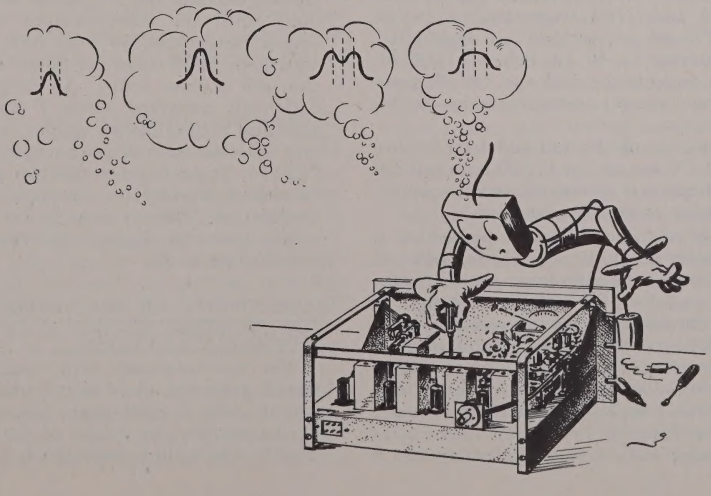
After the warm-up period the power supply should be adjusted to furnish 210 volts, d.c. to the receiver. The receiver operating controls should be set to the positions given in the following chart.

CONTROL	POSITION
ATTENUATION switch	0 DB
R.F. GAIN INCREASE	Maximum clockwise
AUDIO GAIN INCREASE	Maximum clockwise
C.W. AND MANUAL-MANUAL-A.V.C. switch	MANUAL
THRESHOLD SENSITIVITY	Maximum clockwise

ALIGNMENT OF I-F AMPLIFIER CIRCUITS

Alignment of the i-f amplifier circuit is the first step in the over-all alignment of the receiver. As previously stated the i-f amplifier circuit operates at a frequency of 12 mc., and is designed to provide a 10-milliwatt receiver output, at a signal-to-noise ratio of 10 to 1, when a signal of 15 microvolts or less is introduced at the mixer-tube grid. Failure to obtain this output, with a 15-microvolt signal input, indicates the need for alignment of the i-f amplifier circuit.

The amplifier has a bandwidth of 140 kc., as measured at points 6 db down from the maximum response point. The bandwidth is obtained by combining the frequency-response characteristics of the 1st and 2nd i-f transformers with the frequency-response characteristics of the 3rd and 4th i-f transformers. Both the



1st and 2nd i-f transformers are overcoupled, and have a double-humped frequency response, with the peaks occurring 70 kc. each side of the 12,000-kc. point, as shown in figure 20A. The 3rd and 4th i-f transformers, which are not overcoupled have a normal frequency response as shown in figure 20B. Combining the frequency-response characteristics of all four i-f transformers yields a fairly uniform band-pass response 140 kc. wide as shown in figure 20C. These factors must all be taken into account in the alignment of the i-f amplifier circuit, and the alignment made accordingly.

To align the i-f amplifier circuit, connect the ungrounded output lead of the signal generator through a .1-uf. capacitor to the mixer-tube control grid (pin 1); connect the grounded output lead to the r-f assembly capacitor frame (chassis). Keep all connections between the receiver and the signal generator as short as possible. Adjust the signal generator to provide the receiver with a 12,000-kc. signal, modulated 30% at 1000 cycles. Adjust the generator output just high enough to cause both a small change in the output-meter reading and 1000-cycle tone in the headset. Adjust the 4th and 3rd i-f transformers by changing the position of the iron core in each transformer winding. First adjust the secondary and then the primary of the 4th i-f transformer (adjustments 229-8 and 229-7) for maximum output-meter indication. (See figure 27 for locations of adjustments.) In like manner adjust secondary and primary of the 3rd i-f transformer (adjustments 229-6 and 229-5). Both the 4th and 3rd i-f transformers are critically coupled and should be accurately peaked. During the entire alignment keep the signal-generator output at the lowest possible level that will provide an alignment indication.

Since the 1st and 2nd i-f transformers are overcoupled, it will be necessary to adjust them at the same deviation (70 kc.) above and below 12,000 kc. in order to obtain a symmetrical selectivity curve. To accomplish this set the signal generator to provide the receiver with a modulated 12,070-kc. signal. Then adjust the 2nd and 1st i-f transformers for maximum output-meter indication. Adjust the secondary of the 2nd i-f transformer first, and the primary next (adjustments 229-4 and 229-3 respectively). Adjust the secondary and primary of the 1st i-f transformer (adjustments 229-2 and 229-1, respectively) in the same order. After these adjustments are completed, set the signal generator to 70 kc. below 12,000 kc. (11,930 kc.), and readjust the 2nd and 1st i-f transformers for maximum output-meter indication at this frequency.

Repeat the adjustment of the 2nd and 1st i-f transformers at both 12,070 kc. and at 11,930 kc. until the receiver-output indication is maximum, and of approximately the same value at both frequencies.

After this phase of the alignment procedure is completed, the receiver should be adjusted for a 10-to-1 signal-to-noise ratio, and the alignment procedure for the 4th, 3rd, 2nd, and 1st i-f transformers should be repeated until no further increase in receiver output can be obtained. When this has been done, the alignment of the i-f amplifier circuit is finished. When properly aligned the i-f amplifier circuit should have a sensitivity, at a 10-to-1 signal-to-noise ratio, of better than 15 microvolts (usually around 10 microvolts) and the output-meter indication should decrease at about the same rate on each side of 12,000 kc. as the signal-generator frequency is varied away from resonance.

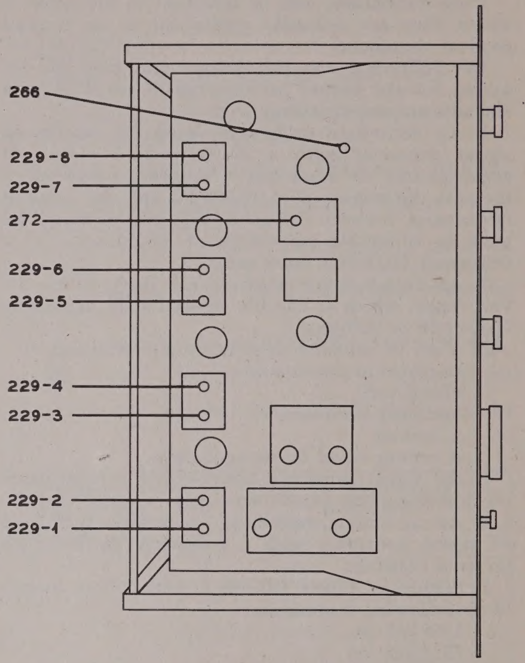


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Figure 27. Radio Receiver BC-639-A, Top View, Showing Location of Adjustments

ADJUSTMENT OF SIGNAL-TO-NOISE RATIO

The standard signal-to-noise ratio is 10 to 1 for a 10-milliwatt output. To obtain this signal-to-noise ratio, the R.F. GAIN INCREASE control and the signal-generator output should be adjusted simultaneously until the power output with modulation on (signal modulated 30% at 1000 cycles) is 10 milliwatts, and is 10 times the power output with modulation off (carrier only). An output-meter reading of 2.45 volts measured across a 600-ohm resistive load indicates a 10-milliwatt output, and a reading of .775 volt indicates a 1 milliwatt output.

NOTE: On some generators the carrier frequency may be shifted slightly by the application or removal of modulation. Thus it may be necessary to retune the signal generator slightly whenever the modulation is switched on or off.

ALIGNMENT OF BEAT-FREQUENCY (C-W) OSCILLATOR CIRCUIT

The beat-frequency (c-w) oscillator, as previously stated, generates an r-f signal whose frequency may be varied, over a small range above and below the i.f. of the receiver, by means of the C.W. TONE CONTROL. The audible tone which is produced when c-w signals are being received is obtained through heterodyne action between the i-f signal and the beat-frequency (c-w) oscillator signal. It is obvious that the C.W. TONE CONTROL changes the frequency difference between the i-f signal and the beat-frequency (c-w) oscillator signal and thus determines the pitch of the audio tone which is produced.

The frequency of the beat-frequency (c-w) oscillator circuit may be varied an equal amount above and below the i.f. of the receiver when zero beat is obtained at the center of the C.W. TONE CONTROL range. Failure to obtain zero beat at this setting of the control indicates a need for alignment of the beat-frequency (c-w) oscillator circuit.

In aligning this circuit it is first necessary to establish the proper relationship between the C.W. TONE CONTROL knob and the C.W. TONE CONTROL shaft. When the C.W. TONE CONTROL knob is set so that the pointer is at the index line at the center of the arrow line, the red line on the shaft attached to the flexible rear coupler should be straight up. If this relationship is not correct, loosen the two Allen set screws in the coupler, make the necessary adjustments, and tighten the setscrews. Variable capacitor 270, which is attached to the shaft, is at the center of its range when the red line is up.

After the above relationship has been properly established, the beat-frequency (c-w) oscillator may be adjusted as follows:

Set the C.W. AND MANUAL-MANUAL-A.V.C. switch to the C.W. AND MANUAL position, and the C.W. TONE CONTROL to the index line. Leave the output meter and signal generator connected as for the i-f amplifier circuit alignment. Adjust the signal generator to provide the receiver with a 12,000-kc. (12-mc.) unmodulated signal of maximum amplitude. Then adjust the position of the iron core in the beat-frequency (c-w) oscillator grid-tank coil 269 for zero beat in the headset. This adjustment is located at the top of the oscillator coil assembly 272 (see figure 27). After zero beat is obtained, turn the C.W. TONE CONTROL, either to the right or to the left, until maximum output is indicated on the output meter, and a tone is heard in the headset. Then adjust the position of the iron core in the beat-frequency (c-w) oscillator plate-tank coil 266 for maximum output. Turn the adjustment one additional turn past the point of peak output, to improve the over-all stability of the circuit. The beat-frequency (c-w) oscillator circuit is now properly adjusted.

ADJUSTMENT OF THE TUNING MECHANISM

The tuning mechanism varies the settings of the variable capacitors which tune the r-f, mixer, h-f oscillator, and doubler circuits. It also provides a direct indication of the frequency to which the receiver is tuned. An improperly adjusted tuning mechanism will cause the wrong frequency to be indicated on the MEGACYCLES dial, and may also prevent complete coverage of the frequency band for which the receiver was designed. When a need for adjustment of the tuning mechanism is indicated, the following procedure should be used:

1. The quadrant gear on the gear drive assembly should be checked first to ascertain whether its edges touch the casting when the tuning knob is rotated from stop to stop. If either edge touches the casting, loosen the Allen setscrews on the gear hub, adjust the gear to the proper position, then tighten the Allen setscrews.

2. Next determine whether the line marked STOP on the MEGACYCLES dial is at the index on the dial window when the tuning knob is rotated counterclockwise to its stop. If it is not, loosen the two setscrews on the dial hub, hold the tuning knob against its stop, and properly position the MEGACYCLES dial. Then tighten the setscrews.

3. With the tuning knob set fully counterclockwise, determine whether the two quadrant gears (one mounted on the tuning mechanism and the other on the three-gang capacitor assembly) are meshed so that their top edges are parallel to the chassis. If they are not, loosen the setscrews on the gear hubs and properly position the quadrant gears, then tighten the setscrews.

4. Rotate the tuning knob clockwise until the ALIGN mark on the MEGACYCLES dial is at the index on the dial window. While holding the dial in this position, check both the two-gang and three-gang capacitors to determine whether the rotor (movable) plates are flush with the stator (fixed) plates. The three-gang capacitor should be checked at the left side, and the two-gang capacitor at the right side, as viewed from the front panel of the receiver. If the three-gang capacitor is not fully meshed, loosen the two set screws on the quadrant gear attached to the three-gang capacitor and properly position the capacitor plates. Then tighten the setscrews and recheck. If the two-gang capacitor is not fully meshed, loosen the two setscrews on the flexible coupler, which couples the dial drive and gear assembly to the two-gang capacitor, and properly position the capacitor plates. Then tighten the setscrews and recheck. When both capacitors are properly set, the adjustment of the tuning mechanism is finished.

ALIGNMENT OF THE H-F OSCILLATOR, DOUBLER, MIXER, AND R-F AMPLIFIER CIRCUITS

Proper alignment of the h-f oscillator, doubler, mixer, and the r-f amplifier circuits is essential to the correct frequency relationship between the incoming r-f signal selected by the r-f amplifier and mixer circuits, and the local signal produced by the h-f oscillator and doubler circuits. This relationship must always be such that the difference frequency (i.f.) is exactly 12 mc. If this relationship is not maintained, incorrect dial calibration and low receiver sensitivity may result. Low receiver sensitivity or improper dial calibration generally indicates the need for alignment. However, since the alignment is a very difficult operation, it should not be attempted until it has been definitely determined that alignment is necessary. Indiscriminate alignment should be avoided.

Before alignment is attempted the tuning mechanism should be checked for proper adjustment. If the tuning mechanism is correctly adjusted but the dial calibration is incorrect, the need for alignment is immediately indicated. However, if the dial calibration is correct but improper alignment is suspected, a series of sensitivity measurements should be made 10 mc. apart, beginning at 100 mc. At each check point the receiver should provide a 10-milliwatt output, at a signal-to-noise ratio of 10 to 1, when a signal of 5 microvolts or less is introduced into the receiver antenna coupling socket, 200. If the sensitivity is too low, the need for alignment is indicated.

Before aligning the h-f oscillator, doubler, mixer, and r-f amplifier circuits, turn both the THRESHOLD SENSITIVITY control and the R.F. GAIN INCREASE control fully clockwise. Connect the 70-ohm output of the signal generator to the antenna coupling socket of the receiver. Adjust the signal generator to provide a 156-mc. signal, modulated 30% at 1000 cycles. Tune the receiver to 156 mc. and then adjust the signal-generator output to a level just high enough to cause a small change in the output-meter reading and to provide a 1000-cycle tone in the headset.

Adjust the oscillator trimmer, 204-5 (lower screw on the front section of the two-gang capacitor), for maximum output as indicated by both the output meter and the sound in the headset. (See figure 28 for locations of adjustments.) Adjust the following trimmers, in the order given, for maximum receiver output: the doubler trimmer, 204-4 (on the rear section of the two-gang capacitor), the mixer trimmer, 204-3 (on the rear section of the three-gang capacitor), and the r-f amplifier plate and grid trimmers, 204-2 and 204-1 (on the center and front sections, respectively, of the three-gang capacitor).

It may be necessary to use a strong signal-generator output at first, but as the circuits are brought into resonance the output should be reduced to the lowest level that will provide a good indication for alignment purposes. It may also be necessary to reduce the setting of the R.F. GAIN INCREASE control, in order to obtain a satisfactory indication.

Next tune the signal-generator and receiver to 100 mc., and adjust the inductance of the h-f oscillator coil, 223 (top screw on the front section of the two-gang condenser), for maximum output as indicated by the output meter or sound in the headset. See figure 28 for location of adjustment.

Using a tuning wand, check each h-f coil to determine whether its inductance needs to be increased or decreased in order to obtain maximum deflection on the output meter. This check is made by placing each end of the tuning wand near the coil being checked while observing the output-meter indication. If the output-meter reading increases when the brass end of the tuning wand is placed near the coil, the inductance should be decreased by spreading the coil turns. If the reading increases when the iron-slug end of the wand is placed near the coil, the inductance should be increased by squeezing the coil turns closer together. If the reading decreases when each end of the tuning wand is placed near the coil, the coil is properly tuned and no adjustment of its inductance is required. Any necessary adjustments of the coil inductances should be made with insulated tools.

When this part of the procedure is completed, check the accuracy of the dial calibration at 156 mc. and at 100 mc. If the dial calibration is off, adjust the oscillator trimmer, 204-5, until the 156-mc. signal is received at 156 on the dial; then adjust the oscillator inductance until the 100-mc. signal is received at 100 on the dial. It may be necessary to repeat both adjustments several times to obtain accurate dial calibration.

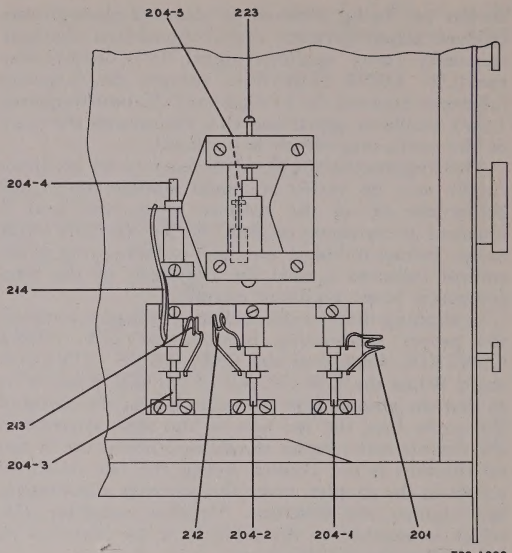

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Figure 28. R-F and Oscillator Assemblies, Showing Location of Adjustments

After the dial calibration is properly set, re-adjust the r-f amplifier, mixer, and doubler trimmers for maximum output at 156 mc.; then, using the tuning wand, check the inductance of each h-f coil at 100 mc., to determine whether it is properly set for maximum output at this frequency. If necessary, readjust the coil inductance for maximum output.

Next set the signal generator to 130 mc. and tune in the signal on the receiver. Check the spacing between the r-f amplifier plate coil, 212, and mixer-grid coil, 213. The spacing should be such that moving the coils closer together or farther apart causes the output-meter reading to decrease. If necessary, adjust the coil spacing for maximum output. When the coils are properly set, the spacing will be approximately ¼ inch. The position of the doubler-plate coil (hairpin coil), 214, with respect to that of the mixer-grid coil, 213, should also be checked. The position of the coil should be such that moving the coil closer to, or farther away from, the mixer coil causes the output-meter reading to decrease. If necessary, adjust the position of the doubler-plate coil for maximum receiver output. These spacing adjustments serve to set the coils in the proper relationship to each other, so that the circuits will track as the receiver is tuned across its range.

After properly spacing the coils, check each coil with the tuning wand to determine whether its inductance is still of the proper value to give maximum receiver output at 100 mc. If adjustment of the inductances is required, the r-f amplifier coil and mixer-coil inductances should be adjusted by spreading or squeezing the outside turns of the coil for maximum output while holding the inside turn stationary, so that the spacing between the coils remains the same. The inductance of the doubler (hairpin) coil should be adjusted by changing the effective diameter of the loop, or the spacing between the leads to the loop. Make certain that the position of the coil relative to that of the mixer-grid coil remains the same.

Repeat the spacing adjustments at 130 mc., and the inductance adjustments at 100 mc., for the r-f amplifier, mixer, and doubler coils, until no further increase in output can be obtained. Then tune the signal generator and receiver to 156 mc., and readjust the trimmers for these coils for maximum receiver output.

After all of the above adjustments are completed, tune the receiver completely off the signal and set the THRESHOLD SENSITIVITY control for a TUNING METER reading of 5 ma., with the R.F. GAIN INCREASE control at maximum. Then make a series of sensitivity measurements every 10 mc., beginning at 100 mc. the receiver sensitivity should be 5 microvolts, or better, at a signal-to-noise ratio of 10 to 1, and should not vary more than one microvolt from one 10. mc. measuring point to the next. If the sensitivity varies more than this amount, check the placement of the doubler (hairpin) coil at 130 mc.; its relationship to the mixer coil may have been changed when the 100-mc. inductance adjustment was made, thus causing the tracking of the coil to be off at the frequency where less sensitivity is obtained.

Frequency Meter BC-638-A may be used, instead of a signal generator, to align the r-f amplifier, mixer, and h-f oscillator circuits. The frequency meter should be equipped with crystals which will provide signals near the specific alignment frequencies required. The frequency-meter antenna should be in place, so that a signal can be transmitted to the receiver. The receiver antenna, which is a duplicate of the frequency-meter antenna, should also be in place. The receiver should be aligned in the same manner as when using a signal generator. During alignment the signal should be kept at as low a level as possible. Of course when the BC-638-A is used for alignment purposes, it will not be possible to establish the standard signal-to-noise ratio of 10 to 1 or to measure the receiver sensitivity, however, this fact does not prevent the use of the instrument in making all of the alignment adjustments.

ADJUSTMENT OF THE RECEIVER THRESHOLD SENSITIVITY

After the entire alignment is completed and before the receiver is placed in normal use, the THRESHOLD SENSITIVITY control should be carefully set. First, check the power supply and, if necessary, adjust it for the proper output voltages. Disconnect and turn off the signal generator and/or frequency meter. Ground the antenna input of the receiver to the chassis. Then with the R.F. GAIN INCREASE control set at maximum carefully adjust the THRESHOLD SENSITIVITY control for a TUNING METER reading of 5 ma.

LESSON PLAN No. 14

TIME ALLOTTED: 2½ HR.

SUBJECT

Alignment and adjustment.

OBJECTIVE

To familiarize the trainee with the procedure for completely aligning and adjusting Radio Receiver BC-639-A.

INTRODUCTION

The over-all sensitivity and selectivity of Radio Receiver BC-639-A depends primarily upon the proper alignment of its circuits.

SUBJECT MATERIAL

1. Determining need for over-all alignment.
2. Types of alignment procedures.
3. Tools needed in performing the alignment procedures.
    a. Multiband r-f signal generator.
    b. Output meter.
    c. Insulated aligning tools.
4. Additional tools needed in case the multiband r-f signal generator is not available.
    a. R-f signal generator, with a frequency range which includes 12,000 kc.
    b. Frequency Meter BC-638-A with three crystals (5555.555 kc, 7222.222 kc, and 8666.666 kc.)
5. Preparing the receiver for alignment.
    a. Removing the cover.
    b. Connecting the load.
    c. Warm-up.
    d. Adjustment of power-supply voltages.
    e. Setting of controls.
6. Alignment of the i-f amplifier circuit.
    a. Operating characteristics of the i-f amplifier.
        (1) Sensitivity.
        (2) Bandwidth.
        (3) Response characteristics of the 1st and 2nd i-f amplifier stages.
        (4) Response characteristics of the 3rd and 4th i-f amplifier stages.
    b. Connection and adjustment of signal generator for i-f alignment.
    c. Procedure for adjusting the 4th and 3rd i-f transformers.
    d. Procedure for adjusting the 2nd and 1st i-f transformers.
    e. Procedure for completing the i-f amplifier alignment.
    f. Characteristics of a properly aligned i-f amplifier circuit.
7. Procedure for adjusting the receiver for the standard 10-to-1 signal-to-noise ratio.
8. Alignment of the beat-frequency (c-w) oscillator circuit.
    a. Purpose of the b.f.o. and the principles of its operation.
    b. How to determine whether the b.f.o. needs alignment.
    c. Procedure for properly positioning the C.W. TONE CONTROL.
    d. Procedure for aligning the b-f-o circuit.
9. Adjustment of the tuning mechanism.
    a. Purpose of the tuning mechanism.
    b. Preliminary adjustment of the quadrant gears.
    c. Adjustment of the MEGACYCLES dial.
    d. Final adjustment of the quadrant gears.
    e. Adjustment of the tuning capacitors.
10. Alignment of the h-f oscillator, doubler, mixer, and r-f amplifier circuits.
    a. Importance of proper alignment.
    b. Result of improper alignment.
        (1) Low receiver sensitivity.
        (2) Improper dial calibration.
    c. Reasons for avoiding indiscriminate alignment.
    d. Checks for determining whether alignment is needed.

e. Preparations for alignment.

(1) Setting of the receiver controls.

(2) Connection and adjustment of the signal generator.

f. Procedure for aligning the circuits at the high-frequency end (156 mc.).

(1) Adjustment of the h-f oscillator trimmer.

(2) Adjustment of the doubler, mixer, and r-f amplifier trimmers.

(3) Adjustment of the signal-generator output during alignment.

g. Procedure for aligning the circuits at the low-frequency end (100 mc.).

(1) Adjustment of the h-f oscillator inductance.

(2) Use of the tuning wand for checking the alignment of the r-f amplifier, mixer, and doubler coils, and the procedure for adjusting the coil inductances.

h. Procedure for establishing proper dial calibration, with maximum receiver output, at both ends of dial.

i. Procedure for making the coil-spacing adjustments at 130 mc.

j. Procedure for re-establishing correct alignment at 100 mc.

k. Necessity of repeating the 130-mc. spacing adjustments, and the 100-mc. inductance adjustments.

l. Sensitivity measurements for determining whether alignment is properly made.

m. Corrective measures for nonuniform sensitivity.

n. Use of Frequency Meter BC-638-A for alignment purposes.

11. Adjustment of the receiver threshold sensitivity.

CONCLUSIONS

Receiver misalignment is usually the cause of poor receiver sensitivity and selectivity and of incorrect dial calibration. However, due to the difficulty of adjusting some of the circuits, it is advisable to make alignment checks before starting the alignment procedure. Often the realignment of only a single circuit will restore the original operating performance of a receiver.

ORAL QUIZ

1. How many different alignment procedures are involved in the over-all alignment of the BC-639-A?

2. What test equipment is required in performing the over-all alignment?

3. When a multiband r-f signal generator is unavailable, what test equipment may be used in its place?

4. How should the receiver be prepared for alignment?

5. Why is it necessary to align the i-f amplifier circuit at three different frequencies?

6. Where is the signal generator connected for the alignment of the i-f amplifier circuit?

7. What is meant by "adjusting the receiver for a 10-to-1 signal-to-noise ratio"?

8. How can it be determined whether the b-f-o circuit needs alignment?

9. What checks are made on the tuning mechanism to determine whether it is properly adjusted?

10. Why must the r-f amplifier, mixer, doubler, and h-f oscillator be properly aligned?

11. Why should indiscriminate alignment of these circuits be avoided?

12. What checks are used to determine whether these circuits should be aligned?

13. Where should the signal generator be connected for aligning the r-f amplifier, mixer, doubler, and h-f oscillator circuits?

14. At what frequency are the trimmer capacitors for these circuits adjusted?

15. How are the circuits aligned at the low-frequency end of the dial?

16. What two adjustments are used to establish correct dial calibration at the high and low-frequency ends of the dial?

17. What adjustments are made at 130 mc.?

18. Should any of the alignment procedures be repeated during the over-all alignment of the receiver?

19. What is generally the cause of nonuniform sensitivity over the operating band of the receiver?

20. Can Frequency Meter BC-638-A be used for properly aligning the i-f amplifier circuit? For aligning the h-f circuits?

21. Is Frequency Meter BC-638-A generally used for measuring the sensitivity and selectivity of Radio Receiver BC-639-A?

22. Can Frequency Meter BC-638-A be used for checking the accuracy of the dial calibration?

23. Is it desirable to use a high signal level when aligning the receiver circuits?

24. What is the correct setting for R.F. GAIN INCREASE control when the final adjustment of the threshold sensitivity is made?

25. Should the final adjustment of the threshold sensitivity be made while a signal is being received?

EXPERIMENT No. 10

TIME ALLOTTED: 3 HR.

SUBJECT

Alignment and adjustment.

OBJECTIVE

To become familiar with the alignment and adjustment procedure for Radio Receiver BC-639-A.

EQUIPMENT REQUIRED

1 Radio Receiver BC-639-A.
1 Rectifier Unit RA-42-B.
1 Power supply cable equipped with two Jones connector sockets.
1 R-f signal generator (same as used in Experiment No. 3).

1 Output meter or an a-c voltmeter with a 30-volt range, capable of accurately measuring 1000-cycle a-c voltages.
1 Set of insulated aligning tools consisting of:
Insulated or plastic pliers.
Plastic rod.
Insulated screw driver.
1 Tuning wand, or equivalent.
1 Headset.
1 600-ohm, two-watt carbon resistor.

If the signal generator listed above is unavailable, the following instruments may be used instead.

1. An accurately calibrated, internally modulated r-f signal generator with a frequency range which includes 12,000 kc.

2. Frequency Meter BC-638-A equipped with three crystals of the following frequencies: 5555.555 kc., 7222.222 kc., and 8666.666 kc.

INSTRUCTIONS

The receiver alignment has been upset by the instructor. Using the alignment procedures given below, and the information given in previous experiments and lectures, restore the receiver to its correctly aligned condition. Prepare for the alignment as follows: Remove the dust cover from the receiver. Connect the receiver to the power supply. Connect the 600-ohm carbon resistor in parallel with the output meter, or an a-c voltmeter, across the receiver-output terminals. Also plug a headset into the MONITOR jack on the receiver front panel. Connect the signal-generating instruments and the receiver power supply to the power source; allow all units to warm-up for about 15 minutes.

After the warm-up period adjust the power supply to furnish 210 volts, d.c., to the receiver. Set the receiver operating controls to the positions given in the following chart.

CONTROL	POSITION
ATTENUATION switch	0 DB
R.F. GAIN INCREASE	Maximum clockwise
AUDIO GAIN INCREASE	Maximum clockwise
C.W. AND MANUAL-MANUAL-A.V.C. switch	MANUAL
THRESHOLD SENSITIVITY	Maximum clockwise

During the i-f alignment maintain the receiver output below 5 volts, by reducing the signal-generator output and, whenever necessary, the receiver sensitivity.

ALIGNMENT OF I-F AMPLIFIER AND C-W OSCILLATOR

For the i-f amplifier and c-w-oscillator alignment, connect the ungrounded output lead to the receiver chassis.

ALIGNMENT OF H-F OSCILLATOR, DOUBLER, MIXER, AND R-F AMPLIFIER

For the alignment of the v-h-f circuits, connect the signal generator to the antenna coupling socket of the receiver. If a signal generator of the proper type is not available, Frequency Meter BC-638-A may be used instead. When the frequency meter is to be used prepare it as outlined in Experiment No. 2 and then set it within a few feet of the receiver. Ordinarily direct connection between the receiver and the frequency meter is not necessary, except possibly when the circuits are very badly misaligned. Whenever necessary, the coaxial cable furnished with the frequency meter can be used to connect the output of the frequency meter to the antenna-coupling socket of the receiver. Before aligning the v-h-f circuits, set the receiver controls to the positions given in the chart which precedes the I-F-AMPLIFIER AND C-W-OSCILLATOR ALIGNMENT CHART. During the alignment, maintain the receiver output below 5 volts. CAUTION: Use care in making the alignment adjustments.

H-F-OSCILLATOR, DOUBLER, MIXER, AND R-F-AMPLIFIER ALIGNMENT CHART

STEP	FREQUENCY SETTING OF SIGNAL GENERATOR AND RECEIVER	INSTRUCTIONS	ADJUSTMENTS
1	156 mc.	Adjust trimmers, in order given, for maximum receiver output.	204-5 204-4 204-3 204-2 204-1
2	100 mc.	Adjust h-f-oscillator coil inductance for maximum receiver output.	223
3	100 mc.	Check r-f coils with tuning wand for maximum receiver output. See Note C. Adjust inductance of only those coils which need adjustment.	213 212 201 214

H-F-OSCILLATOR, DOUBLER, MIXER, AND R-F-ALIGNMENT CHART (Continued)

STEP	FREQUENCY SETTING OF SIGNAL GENERATOR AND RECEIVER	INSTRUCTIONS	ADJUSTMENTS
4	156 mc.	Adjust h-f oscillator trimmer for maximum receiver output.	204-5
5	100 mc.	Adjust h-f-oscillator coil inductance for maximum receiver output.	223
6		Repeat steps 4 and 5, until dial calibration at both frequencies is correct.	
7	156 mc.	Adjust trimmers, in order given, for maximum receiver output.	204-4 204-3 204-2 204-1
8	100 mc.	Same as step 3.	
9	130 mc.	Adjust receiver tuning control for maximum output; then adjust spacing between r-f-amplifier plate coil and mixer grid coil for maximum receiver output.	212 213
10	130 mc.	Adjust position of hairpin coil in relation to that of mixer grid coil for maximum receiver output.	214
11	100 mc.	Same as step 3. See Note D.	212 213 214
12		Repeat steps 9, 10, and 11 until no further increase in output can be obtained.	
13	156 mc.	Adjust trimmers, in order given, for maximum receiver output.	204-4 204-3 204-2 204-1
14		Turn signal generator off. Adjust receiver threshold sensitivity by turning THRESHOLD SENSITIVITY control until TUNING METER indicates 5 ma.	THRESHOLD SENSITIVITY control

I-F AMPLIFIER AND C-W-OSCILLATOR CHART

I-F Amplifier

STEP	SIGNAL-GENERATOR SETTING	SPECIAL INSTRUCTIONS	ADJUSTMENTS
1	Modulated 12.0-mc. signal (exact). See Note A.	Adjust 4th and 3rd i-f transformer trimmers, in order given, for maximum output.	229-8 229-7 229-6 229-5
2	Repeat step 1.		
3	Modulated 12,070-kc. signal (exact).	Adjust 2nd and 1st i-f transformer trimmers, in order given, for maximum output.	229-4 229-3 229-2 229-1
4	Modulated 11,930-kc. signal (exact).	Same as step 3.	
5	Repeat steps 3 and 4.		
6	Adjust receiver for 10-to-1 signal-to-noise ratio as follows:		
6a	Modulated 12.0-mc. signal (exact).	Adjust signal-generator output for receiver output of 2.45 volts.	

I-F AMPLIFIER AND C-W-OSCILLATOR CHART (Continued)

I-F Amplifier

STEP	SIGNAL-GENERATOR SETTING	SPECIAL INSTRUCTIONS	ADJUSTMENTS
6b	Turn signal-generator modulation off. See Note B.	Adjust R.F. GAIN INCREASE control for .775-volt receiver output.	
6c	Turn signal-generator modulation on. See Note B.	Same as step 6a.	
6d	Same as step 6b.		
6e	Repeat steps 6c and 6b until 10-to-1 signal-to-noise ratio is established.		
7	Repeat steps 1, 3, and 4 until no further increase in output can be obtained.		
8	Repeat steps 3 and 4 until output at each frequency is the same.		

C-W Oscillator

STEP	SIGNAL-GENERATOR SETTING	SPECIAL INSTRUCTIONS	ADJUSTMENTS
9	Unmodulated 12-mc. signal.	Set C.W. AND MANUAL-MANUAL-A.V.C. switch to C.W. AND MANUAL. Set C.W. TONE CONTROL to center mark. Adjust tuning slug for zero beat in headset.	272
10	Same as step 9.	Turn C.W. TONE CONTROL clockwise until a tone of approximately 1000 cycles is heard in headset. Adjust tuning slug for maximum output; then rotate tuning slug one additional turn clockwise.	266

NOTE A: If in step 1 it is impossible to obtain a receiver output when the signal-generator output is at maximum, vary the signal-generator frequency until the signal can be heard. Tune the generator halfway between this frequency and 12.0 mc., and adjust all trimmers for maximum output; then proceed with step 1 of the alignment procedure.

NOTE B: On some generators the carrier frequency may be shifted slightly by the application or removal of modulation; thus it may be necessary to retune the signal generator slightly whenever modulation is switched on or off.

ADJUSTMENT OF TUNING MECHANISM

To adjust the tuning mechanism, proceed as directed in the following chart.

TUNING-MECHANISM ADJUSTMENT CHART

STEP	OPERATION	TUNING-CONTROL KNOB-SETTING	METHOD OF ADJUSTING
1	To position quadrant gear on gear-drive assembly so that neither edge touches casting when tuning knob is rotated from stop to stop.	Rotate from stop to stop.	Loosen Allen setscrews on gear hub, adjust gear, and retighten setscrews.
2	To position MEGACYCLES dial so that line marked STOP is at index on dial window.	Rotate in counterclockwise direction to stop.	Loosen the two setscrews on dial hub. Hold tuning knob against stop and position dial; then retighten setscrews.
3	To position the two quadrant gears so that their top edges are parallel to chassis.	Same as step 2.	Loosen setscrews on gear hubs, position gears, then retighten setscrews.
4	To position the two-gang and three-gang capacitors so that their rotor (movable) plates are flush with their stator (fixed) plates.	Rotate in clockwise direction until line marked ALIGN on MEGACYCLES dial is at index in dial window.	Loosen setscrews on quadrant gear, attached to the three-gang capacitor, position the three-gang-capacitor plates, and retighten setscrews. Loosen setscrews on flexible coupler which couples dial drive and gear assembly to the two-gang capacitor, position the two-gang capacitor plates, then retighten setscrews.

NOTE C: Check the r-f coils by placing each end of the tuning wand near the coil to be checked while observing the receiver output. If the receiver output increases when the brass end of the tuning wand is near the coil, the coil inductance is too high and must be decreased by spreading the coil turns. If the receiver output increases when the iron-slug end of the tuning wand is near the coil, the coil inductance is too low and must be increased by squeezing the coil turns closer together. If the receiver output decreases when each end of the tuning wand is placed near the coil, the coil inductance is correct and needs no adjustment.

NOTE D: To adjust the r-f-amplifier and mixer-coil inductance, spread or squeeze together the outside turns of the coil for maximum receiver output, while holding the inside turn stationary so that the spacing between the two coils is not changed. To adjust the doubler-coil inductance, decrease or increase the effective diameter of the loop, or the spacing between the loop leads. Be careful not to change the spacing between this coil and the mixer-grid coil.

CONCLUSIONS

1. What equipment is required for the i-f alignment of Radio Receiver BC-639-A?
2. What must be done in preparing the receiver for alignment?
3. Give the order in which the i-f transformers are aligned.
4. Why must the tuning mechanism be correctly adjusted before making any h-f-oscillator, doubler, mixer, and r-f-amplifier adjustments?
5. When using Frequency Meter BC-638-A for alignment, is it necessary to connect the frequency-meter output directly to the receiver antenna-coupling socket?
6. During alignment, is the receiver output maintained at a high or a low level?
7. In what order are the trimmers in the v-h-f section of the receiver adjusted?
8. Why are the inductances in the v-h-f section of the receiver adjusted for maximum receiver output at the low-frequency end of the receiver band?
9. How is the THRESHOLD SENSITIVITY control adjusted?
10. How is a tuning wand used to determine whether a coil has the proper inductance for maximum receiver output?

EXPERIMENT No. 11

TIME ALLOTTED: 3 HR.

SUBJECT

Performance checks.

OBJECTIVE

To become familiar with the over-all performance tests for Radio Receiver BC-639-A.

EQUIPMENT REQUIRED

1 Radio Receiver BC-639-A.
1 Rectifier Unit RA-42-B.
1 Power-supply cable equipped with two Jones connector sockets.
1 R-f signal generator (same as used in Experiment No. 3).
1 Output meter, with a 30-volt range, capable of accurately measuring 1000-cycle a-c voltages.
1 600-ohm, a 200-ohm, and a 20,000-ohm carbon resistor, each at two watts.
1 Audio signal generator.

INSTRUCTIONS

Connect the 600-ohm resistor in parallel with the output meter across the receiver-output terminals. Connect the receiver to the power supply. Connect the power-supply and the signal generators to the power source and allow the equipment to warm-up for several minutes. After the warm-up period, adjust the power supply to furnish 210 volts, d.c., to the receiver. Set the receiver operating controls to the positions given in the following chart.

CONTROL	POSITION
ATTENUATION switch	0 DB
R. F. GAIN INCREASE	Maximum clockwise
AUDIO GAIN INCREASE	Maximum clockwise
C. W. MANUAL-MANUAL-A.V.C. switch	Manual
THRESHOLD SENSITIVITY	For TUNING METER reading of 5 ma.

I-F SENSITIVITY CHECK

1. Set the r-f signal generator to provide a 12-mc. signal, modulated 30% at 1000 cycles.
2. Connect the generator output directly to the grid of the mixer tube.
3. Adjust the receiver sensitivity for a 10-to-1 signal-to-noise ratio as outlined in step 6 of Experiment No. 10.
4. The signal input for a 10-milliwatt (2.45-volt) receiver output at this signal-to-noise ratio should be less than 15 microvolts.

I-F SELECTIVITY CHECK

1. With the r-f signal generator and receiver set up as directed in steps 1, 2, and 3 of the I-F SENSITIVITY CHECK, increase the generator output to twice the value of the i-f sensitivity; then adjust the generator frequency above and below resonance to the frequencies which produce the standard receiver output of 10 milliwatts (2.45 volts).

2. Compute and record the total bandwidth.

3. Increase the generator output to 100 times and 1000 times the value of the i-f sensitivity. In each case adjust the generator frequency above and below resonance to the frequencies which produce the standard receiver output of 10 milliwatts.

4. The receiver selectivity should conform with the following:

SIGNAL-GENERATOR OUTPUT SETTING	BANDWIDTH
2 times i-f sensitivity value	More than 130 kc.
100 times i-f sensitivity value	Less than 350 kc.
1000 times i-f sensitivity value	Less than 450 kc.

FIDELITY CHECK

1. With the r-f signal generator and receiver set up as directed in steps 1, 2, and 3 of the I-F SENSITIVITY CHECK, turn off the internal modulation on the signal generator. Connect an audio signal generator to the external modulation terminals of the r-f signal generator so that it may be modulated 30% at any audio frequency from 200 to 5000 cycles per second.

2. Adjust the frequency of the audio frequency signal generator to 1000 cycles, and adjust its output for 30% modulation of the r-f generator signal.

3. Adjust the r-f signal-generator output to 10 times the value of the i-f sensitivity; then decrease the receiver sensitivity by means of the R. F. GAIN INCREASE control until the receiver output is again 10 milliwatts (2.45 volts).

4. Increase the r-f signal-generator output until the receiver output is 50 milliwatts (5.48 volts).

5. Vary the audio-signal-generator frequency from 200 cycles to 5000 cycles while maintaining the r-f signal-generator level at 30%.

6. The audio response of the receiver is fairly flat and should not vary more than + 2 db to — 6 db from 600 to 2500 cycles, inclusive, as referred to the 50-milliwatt, 1000-cycle reference level.

This is equivalent to an output-meter change of 1.42 volts above to 2.74 volts below the 50-milliwatt 1000-cycle reference level of 5.48 volts. The response at 200 cycles and at 5000 cycles should be attenuated at least 10 db. as referred to the 50-milliwatt reference level. This is equivalent to a change of 3.7 volts on the output meter.

OUTPUT-REGULATION CHECK

1. With the r-f signal generator and receiver set up as directed in steps 1, 2, and 3 of the I-F SENSITIVITY CHECK, adjust the signal-generator output to ten times the value of the i-f sensitivity; then decrease the receiver sensitivity by means of the R. F. GAIN INCREASE control until the receiver output is again 10 milliwatts (2.45 volts).

2. Increase the signal-generator output until the receiver output is 50 milliwatts (5.48 volts). Record the output indication.

3. Turn off the receiver power. Replace the 600-ohm resistor connector to the receiver-output terminals with a 200-ohm resistor; then turn on the receiver power again. Record the receiver-output indication.

4. Again turn off the receiver power. Replace the 200-ohm resistor connected to the receiver-output terminals with a 20,000-ohm resistor; then turn on the receiver power. Record the receiver-output indication.

5. The receiver-output regulation should be such that the receiver output at 1000 cycles will not change more than ± 6 db., as referred to the 600-ohm, 50-milliwatt reference level, for changes in output-load impedances of 200 to 20,000 ohms. For the 200-ohm load impedance, this is equivalent to a change in output-meter indication of .84 volt above to 3.9 volts below the 50-milliwatt (600-ohm) reference indication of 5.48 volts. For the 20,000-ohm load impedance, this is equivalent to a change in output-meter indication of 10.32 volts to 57.72 volts above the 50-milliwatt (600-ohm) reference indication of 5.48 volts.

OVER-ALL SENSITIVITY CHECK

1. Prepare the r-f signal generator to provide signals between 100 mc. and 156 mc., modulated 30% at 1000 cycles.

2. With the receiver set up as outlined in the instructions at the beginning of this experiment, connect the output of the r-f signal generator to the receiver antenna-coupling socket, through a suitable dummy antenna (14-ohm noninductive resistor for this signal generator).

3. Make a series of sensitivity measurements, 10 mc. apart, over the frequency range of the receiver, beginning at 100 mc. At each test frequency between 100 mc. and 156 mc., adjust the receiver sensitivity for a 10-to-1 signal-to-noise ratio, as follows:

   a. Adjust the signal-generator output for a receiver output of 10 milliwatts (2.45 volts).

   b. Turn the signal-generator modulation off, and adjust the receiver sensitivity with the R. F. GAIN INCREASE control for a receiver output of 1 milliwatt (.775 volt).

   c. Turn the signal generator modulation on, and repeat step 3a.

   d. Same as step 3b.

   e. Repeat steps 3b and 3c until a 10-to-1 signal-to-noise ratio is established. If this ratio cannot be obtained, set the receiver for the best possible signal-to-noise ratio and make the sensitivity check.

4. The signal input for a 10-milliwatt receiver output at a signal-to-noise ratio of 10 to 1 should be 5 microvolts, or less, at each test frequency, and should not vary more than 1 microvolt from one 10-mc. test frequency to the adjacent 10-mc. test frequency.

IMAGE-FREQUENCY-REJECTION CHECK

1. With the receiver and signal generator set up as directed in steps 1, 2, and 3 of the OVER-ALL SENSITIVITY CHECK, record the signal input required to produce a 10-milliwatt receiver output (2.45 volts).

2. At each test frequency, adjust the signal-generator frequency to the image frequency (signal frequency less twice the intermediate frequency of the receiver), and increase the signal-generator output until the receiver output is 10 milliwatts. Record the signal input required to produce the 10-milliwatt output.

3. The ratio of the signal inputs required to produce a 10-milliwatt output at the image frequency and at the signal frequency is the image-rejection ratio. This ratio should be greater than 3000 to 1.

INTERMEDIATE-FREQUENCY-REJECTION CHECK

1. With the receiver and signal generator set up as directed in steps 1, 2, and 3 of the OVER-ALL SENSITIVITY CHECK, record the signal input required to produce a 10-milliwatt receiver output (2.45 volts).

2. At each test frequency, adjust the signal generator to the intermediate frequency of the receiver (12 mc.), and increase the generator output until the receiver output is 10 milliwatts (2.45 volts).

3. The ratio of the signal inputs required to produce a 10-milliwatt receiver output at the intermediate frequency and at the signal frequency is the intermediate-frequency-rejection ratio. This ratio should be greater than 20,000 to 1.

NOTE B: A correct indication of the intermediate-frequency-rejection ratio will not be obtained on test frequencies at or near harmonics of the intermediate frequency.

UNDESIRED-FREQUENCY-REJECTION CHECK

1. With the receiver and signal generator set up as directed in steps 1, 2, and 3 of the OVER-ALL SENSITIVITY CHECK, record the signal input required to produce a 10-milliwatt receiver output (2.45 volts).

2. At each test frequency, adjust the signal-generator output to maximum and vary its frequency from 100 mc. to 160 mc. Record the frequency of each response heard. At each response frequency measure and record the amount of signal input required to produce a 10-milliwatt receiver output.

3. The ratio of the signal inputs required to produce a 10-milliwatt receiver output at the undesired frequency and at the desired frequency is the undesired-frequency-rejection ratio (image frequency and generator harmonics excepted). This ratio should be greater than 10,000 to 1.

TUNING-METER CHECK

1. Prepare the r-f signal generator to provide unmodulated signals between 100 mc. and 156 mc.

2. Set the C.W. AND MANUAL-MANUAL-A.V.C. switch on the receiver to A.V.C.

3. With the receiver set up as outlined in the instructions at the beginning of this experiment, ground the antenna input to the receiver chassis and adjust the THRESHOLD SENSITIVITY control for a no-signal noise level of 5 to 10 milliwatts.

4. Connect the output of the r-f signal generator to the receiver antenna-coupling socket.

5. Adjust the signal-generator output voltage to each of the following values and observe the TUNING METER indication for each value.

10 microvolts.
100 microvolts.
1 millivolt.
10 millivolts.
100 millivolts.

6. The TUNING METER reading should conform with those listed in the following chart:

10 microvolts (approximate)	5 ma.
100 microvolts (approximate)	4.8 ma.
1 millivolt (approximate)	3.2 ma.
10 millivolts (approximate)	2.0 ma.
100 millivolts (approximate)	1.2 ma.

CALIBRATION-ACCURACY CHECK

1. Check the calibration of the dial over the entire receiver tuning range (100—156 mc.).

2. The accuracy of the dial calibration should be better than ± 1 mc. between 100 and 156 mc., and should be exact at both ends of the dial.

After completing this portion of the experiment, request the instructor to put trouble into the receiver. Using the tests given in the preceding portion of this experiment, locate and correct the trouble. Then inform the instructor what trouble was found and what corrective measures were taken.

CONCLUSIONS

1. What is the sensitivity of the i-f amplifier circuit as measured from the grid of the mixer tube?

2. What is the bandpass of the i-f amplifier circuit for a signal input 100 times the i-f sensitivity?

3. Are 200-cycle and 5000-cycle signals attenuated by the audio amplifier? By what amount?

4. What is the receiver sensitivity at 135 mc.?

5. What is the required image-rejection ratio of the receiver?

6. How accurate should the dial calibration be over the tuning range of the receiver?

LECTURE No. 15

TROUBLE SHOOTING

Quick and efficient location of trouble in an equipment requires the use of a systematic trouble-shooting procedure. The Philco trouble-shooting procedure is logical, thorough, and easy to follow. It is based upon:

First—Localization of the trouble to a functional section, or block of circuits.

Second—Isolation of the faulty circuit within that section.

Third—Location of the defective part within that circuit.

When trouble is found to exist in the equipment, localization of the trouble to a functional section is accomplished, if possible, by a visual inspection and an operational check. The visual inspection should be made first; any apparent trouble indications, such as loose or broken wires, cables, and terminals, which are revealed by this inspection should be corrected. If the visual inspection does not reveal the trouble, systematic operational checks should be made. By means of these checks, the technician often can localize the trouble to a block of circuits immediately, without needless testing.

If the trouble cannot be localized by the operational checks, it should be localized by a step-by-step performance of test-point checks. These checks refer to one or more major test points, ① , ② , etc; a group of key test points, Ⓐ , Ⓑ , etc; and, a group of secondary test points, (A1) , (B1) , etc; all test points are indicated on the Philco schematic diagram and photographs. Tests at the major test points throughout the equipment will localize the trouble to a particular section, and will eliminate other sections from suspicion.

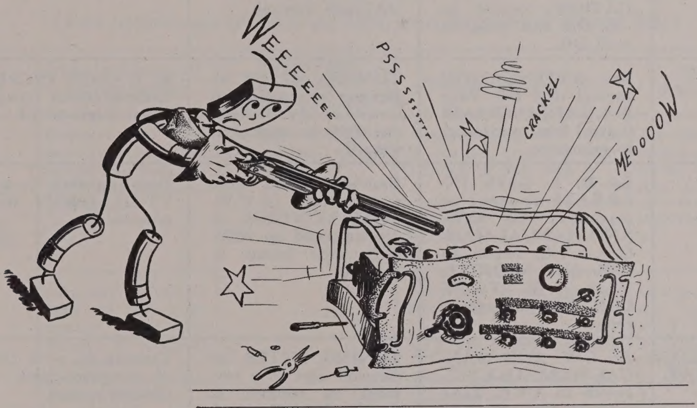
After the trouble has been localized to a section, either by the operational check or by tests at major test points, additional tests at the key and secondary test points will isolate the faulty circuit. The defective part can then be located by testing tubes, by further voltage and resistance measurements, or by substitution of parts.

OPERATIONAL CHECKS

Operational checks on any equipment should be made in proper sequence and should be so designed as to check the operation of a major functional circuit, a small group of circuits, or a portion of a circuit.

The operational checks for the BC-639-A are given in the Operational-Check chart below. Before proceeding with these operational checks, make the following preliminary connections and settings of controls.

1. Plug the headset into the MONITOR jack on the receiver front panel.
2. Set up Frequency Meter BC-638-A within 10 feet of Radio Receiver BC-639-A. Connect the frequency meter to the power source, and install its antenna. Adjust the frequency meter to provide a 130-mc. signal. Then set the STAND BY-OPERATE switch to STAND BY.
3. Make certain that an antenna, similar to the frequency meter antenna, is connected to the receiver.
4. Make certain that the power supply is properly connected to the receiver and to a source of power.



OPERATIONAL-CHECK CHART

STEP	TEST-EQUIPMENT INSTRUCTIONS	RECEIVING-EQUIPMENT INSTRUCTIONS	NORMAL INDICATION	POSSIBLE CAUSE OF ABNORMAL INDICATION
1	None.	Operate POWER ON switch on power-supply unit to on.	Both indicator jewel lamp and dial lamp light.	If both lamps fail to light, check A.C. FUSES, primary power source, and lamps, if these components are normal, trouble is in power supply or voltage distribution system. To locate trouble, proceed with step 1 of test-point-check chart. If only indicator jewel lamp fails to light, check indicator jewel lamp and lamp socket. If only dial lamp fails to light, check dial lamp, lamp socket, power-supply cable, power-output plug 257, power-supply plug 263, and receiver low-voltage distribution system.
2	None.	Set C.W. AND MANUAL-MANUAL-A.V.C. switch to MANUAL. Set R.F. GAIN INCREASE control fully clockwise.	TUNING METER indicates approximately 5 ma.	TUNING METER 240. 1st i-f amplifier tube. Improperly adjusted THRESHOLD SENSITIVITY control. If these components are normal, trouble is in power supply, high-voltage distribution system, or radio receiver; to locate trouble, proceed with steps 1 and 8 of test-point-check chart.

OPERATIONAL-CHECK CHART (Continued)

STEP	TEST-EQUIPMENT INSTRUCTIONS	RECEIVING-EQUIPMENT INSTRUCTIONS	NORMAL INDICATION	POSSIBLE CAUSE OF ABNORMAL INDICATION
3	None.	Set AUDIO GAIN INCREASE control to maximum. Set ATTENUATION control to 0 DB.	Loud, rushing noise is heard in headset.	Tubes. Headset. If these components are normal, trouble is in receiver; to locate trouble, proceed with step 8 of test-point-check chart.
4	Set STAND BY-OPERATE switch on frequency meter to OPERATE. Set OUTPUT CONTROL to MIN.	Tune receiver to signal from frequency meter (MEGACYCLES dial reading of approximately 130 mc.).	Loud, clear, 1000-cycle tone is heard in headset.	Tubes. If tubes are O.K., trouble is in receiver; to locate trouble, proceed with step 8 of test-point-check chart.
5	No change.	Vary AUDIO GAIN INCREASE control from maximum to minimum.	Volume of sound in headset decreases smoothly as control is rotated.	AUDIO GAIN INCREASE control 251.
6	No change.	Set AUDIO GAIN INCREASE control to maximum. Set ATTENUATION control to —6 DB and then to —12 DB.	Volume of sound in headset decreases for each setting of ATTENUATION control.	ATTENUATION control 254.
7	No change.	Set ATTENUATION control to 0 DB. Vary R. F. GAIN INCREASE control from maximum to minimum.	TUNING METER indication and sound in headset decreases smoothly as control is rotated.	R. F. GAIN INCREASE control 242. Cathode-circuit components in i-f amplifier stages or r-f amplifier stage.
8	No change.	Set R. F. GAIN INCREASE control to maximum. Set C.W. AND MANUAL-MANUAL-A.V.C. switch to C.W. AND MANUAL. Vary C.W. TONE CONTROL through its range.	Beat note, which varies with position of C.W. TONE CONTROL, is superimposed on 1000-cycle tone heard in headset.	Beat-frequency (c-w) oscillator tube VT-211 (6SG7) or associated components.
9	Set OUTPUT CONTROL to MAX.	Set C.W. AND MANUAL-MANUAL-A.V.C. switch to A.V.C. Tune receiver through resonance.	TUNING METER indication dips to a low value as receiver is tuned through resonance. Undistorted 1000-cycle tone is heard in headset at resonance.	Trouble in a-v-c circuit; see step 23 of test-point-check chart for list of possible causes.
10	Set frequency meter to provide signals at 100 mc., 156 mc., and 130 mc., in sequence.	Tune receiver to each signal in turn.	TUNING METER reading should be the same for each frequency.	H-f oscillator tube. Doubler tube. Mixer tube. Improper alignment.
11	Connect another headset to output terminals of receiver at plug 263.	No change.	Loud, clear, 1000-cycle tone is heard in headset which is connected to receiver-output terminals.	LINE jack.

TEST-POINT CHECKS

Since operational checks generally serve only in localizing equipment trouble to a block of circuits, which may consist of a number of stages, additional checks in the form of test-point checks are needed to isolate the trouble to a small group of components. One or more test-point checks made at the proper points in the equipment should definitely indicate whether a circuit is operating normally. Test-point checks, like operational checks, should be made in proper sequence in order to locate the cause of equipment trouble quickly. The test-point checks for the BC-639-A are given in the test-point-check chart below. In making these checks the following test equipment is required:

1. Frequency Meter BC-638-A, equipped with crystals of the following frequencies: 5555.555 kc., 7222.222 kc., and 8666.666 kc.
2. R-f signal generator, internally modulated (preferably at 1000 cycles), with a frequency range which includes 12 mc.
3. Audio-frequency signal generator.

4. Multimeter (20,000 ohms per volt), with a-c and d-c ranges which include 750-volt and 30-volt ranges.

5. R-f choke.

6. R-f pickup wire (5-inch piece of insulated #18 A.W.G. hookup wire with ½ inch of insulation removed from one end).

7. 600-ohm, two-watt carbon resistor.

Before proceeding with the test-point checks given in the following chart, the following preliminary connections and settings of controls should be made.

1. After removing the receiver dust cover, reconnect the power supply to the receiver.

2. Plug the headset into the MONITOR jack on the receiver front panel.

3. Connect the 600-ohm, two-watt resistor across the receiver-output terminals (terminals 11 and 12 of power-supply plug 263).

4. Set the receiver operating controls as follows:

R.F. GAIN INCREASE control fully clockwise.
AUDIO GAIN INCREASE control fully clockwise.
ATTENUATION switch to 0 DB.
C.W. AND MANUAL-MANUAL-A.V.C. switch to MANUAL.

5. Make certain that the power supply is connected to the power source.

6. Set Frequency Meter BC-638-A within 10 feet of Radio Receiver BC-639-A. Connect the frequency meter to the power source, and install its antenna in place. Adjust the frequency meter to provide maximum signal at 130 mc. Then set the STAND BY-OPERATE switch to STAND BY.

7. Prepare both the r-f and a-f signal generators for use by connecting them to a power source and allowing them to warm up for several minutes.

TEST-POINT-CHECK CHART
POWER SUPPLY

(For locations of test points, see figures 21 and 26.)

STEP	TEST POINT	TEST-EQUIPMENT INSTRUCTIONS	RECEIVING EQUIPMENT INSTRUCTIONS	NORMAL INDICATION	POSSIBLE CAUSE OF ABNORMAL INDICATION
1 (Part 1)	1 Receiver power-supply plug 263.	Connect a-c voltmeter (30-volt range) between terminal 8 at test point and chassis.	Operate POWER ON switch to on.	Approximately 6.3 volts. If normal, proceed with balance of this step.	Trouble in power supply or voltage-distribution system; to locate trouble, proceed with step 2.
				Indicator jewel lamp lights.	Indicator lamp or lamp socket.
1 (Part 2)		Connect positive lead of d-c voltmeter (750-volt range) to terminal 10 at test point, and connect negative lead to chassis. CAUTION: High voltage.		220 volts. If all test indications at test point 1 are normal, further power-supply checks are unnecessary.	Low primary-power-source voltage. Improperly adjusted SUPPLY VOLTAGE control. Trouble in power supply or voltage-distribution system; to locate trouble, proceed with step 3.
2 (Part 1)	A Terminals 7 and 8 of power-output plug 357.	Connect a-c voltmeter (30-volt range) between terminals 8 and 7 at test point.	Operate POWER ON switch to off. Disconnect power-supply cable at power-output plug 357. Turn SUPPLY VOLTAGE control to 115 VOLTS. Operate POWER ON switch to on.	Approximately 6.3 volts.	A.C. FUSE 361-1 or 361-2. No power at primary power source. POWER ON switch 356. SUPPLY VOLTAGE control 355. Transformer 350.
				Indicator jewel lamp lights.	Indicator lamp or lamp socket.
2 (Part 2)			Operate POWER ON switch to off. Reconnect power supply to power-output plug 357. Operate POWER ON switch to on.	Approximately 6.3 volts. Receiver dial lamp lights.	Dial lamp or lamp socket. Trouble in power-supply cable or voltage-distribution circuits in receiver.
3 (Part 1)	B Terminals 9 and 10 of power-output plug 357.	Connect positive lead of d-c voltmeter (750-volt range) to terminal 10, and connect negative lead to terminal 9. CAUTION: High voltage.	Same as step 2, part 1.	Approximately 350 volts.	D.C. FUSE 361-3 Note: If fuse is blown, check filter capacitors 352-1 and 352-2 for shorts before replacing fuse. Low primary-power-source voltage. Trouble in rectifier circuit; to locate trouble, proceed with step 4.

TEST-POINT-CHECK CHART
POWER SUPPLY (Continued)

(For locations of test points, see figures 21 and 26.)

STEP	TEST POINT	TEST-EQUIPMENT INSTRUCTIONS	RECEIVING EQUIPMENT INSTRUCTIONS	NORMAL INDICATION	POSSIBLE CAUSE OF ABNORMAL INDICATION
3 (Part 2)			Same as step 2, part 2.	220 volts. If normal indications were obtained in steps 2 and 3, further power-supply checks are unnecessary.	Improperly adjusted SUPPLY VOLTAGE control. Power-supply cable or voltage-distribution system in receiver.
4	B1 Terminals 11 and 13 of power transformer 350.	Connect a-c voltmeter (750-volt range) to test point.	Same as step 2, part 1.	Approximately 680 volts.	Transformer 350 (high-voltage winding).
5	B2 Pin 8 of rectifier tube.	Connect positive lead of d-c voltmeter (750-volt range) to test point, and connect negative lead to chassis. CAUTION: High voltage.	No change.	Approximately 350 volts.	Rectifier tube VT-206A, Transformer 350 (rectifier-tube-filament winding). Capacitor 352-1 or 352-2. Resistor 362.
6	B3 Output terminal of choke 351-1.	Same as step 5.	No change.	Approximately 350 volts.	Choke 351-1. Capacitor 352-1 or 352-2. Resistor 362.
7 (Part 1)	B4 Output terminal of choke 351-2.	Same as step 5.	No change.	350 volts.	Choke 351-2. Capacitor 352-2. Resistor 362.
7 (Part 2)			Same as step 2, part 2.	220 volts.	Improperly adjusted SUPPLY VOLTAGE control. Power-supply cable or voltage distribution system in receiver.

RADIO RECEIVER

(For locations of test points, see figures 17 and 21.)

STEP	TEST POINT	TEST-EQUIPMENT INSTRUCTIONS	RECEIVING EQUIPMENT INSTRUCTIONS	NORMAL INDICATION	POSSIBLE CAUSE OF ABNORMAL INDICATION
8 (Part 1)	2 Antenna-coupling socket.	Set STAND BY-OPERATE switch on frequency meter to OPERATE. Set OUTPUT CONTROL to MIN.	Connect an antenna, similar to frequency meter antenna, to antenna-coupling socket of receiver. Tune receiver to frequency of frequency meter (130 mc.).	Loud, clear, 1000-cycle tone heard in headset.	Trouble in receiver circuits; to locate trouble proceed with steps 9, 12, 18, 21, 22, and 23.
8 (Part 2)				TUNING METER indicates 5 ma.	Improperly set THRESHOLD SENSITIVITY control. Cathode-circuit components in i-f amplifier stages.
8 (Part 3)			Vary AUDIO GAIN INCREASE control from maximum to minimum.	Volume of sound in headset decreases smoothly as control is rotated.	AUDIO GAIN INCREASE control 251.
8 (Part 4)			Set AUDIO GAIN INCREASE control to maximum. Set ATTENUATION control to —6DB, and then to —12 DB.	Volume of sound in headset decreases for each setting of ATTENUATION control.	ATTENUATION control 254.

TEST-POINT-CHECK CHART
RADIO RECEIVER (Continued)
(For locations of test points, see figures 17 and 21.)

STEP	TEST POINT	TEST-EQUIPMENT INSTRUCTIONS	RECEIVING EQUIPMENT INSTRUCTIONS	NORMAL INDICATION	POSSIBLE CAUSE OF ABNORMAL INDICATION
8 (Part 5)			Set ATTENUATION control to 0 DB. Vary R.F. GAIN INCREASE control from maximum to minimum.	TUNING METER indication and sound in headset decrease smoothly as control is rotated.	R.F. GAIN INCREASE control 242. Cathode-circuit components in i-f amplifier stages or r-f amplifier stage.
8 (Part 6)			Set R.F. GAIN INCREASE control to maximum. Set C.W. AND MANUAL-MANUAL - A.V.C. switch to C.W. AND MANUAL. Vary C.W. TONE CONTROL through its range.	Beat note which varies with position of C.W. TONE CONTROL is superimposed on 1000-cycle tone heard in headset.	Trouble in c-w oscillator circuit; see step 22 for list of possible causes.
8 (Part 7)		Set OUTPUT CONTROL on frequency meter to MAX.	Set C.W. AND MANUAL - MANUAL-A.V.C. switch to A.V.C. Tune receiver through resonance.	TUNING METER indication dips to a low value as receiver is tuned through resonance. Undistorted tone is heard in headset at resonance.	Trouble in a-v-c circuit; see step 23 for list of possible causes.
8 (Part 8)		Set OUTPUT CONTROL on frequency meter to MIN. Connect multimeter (100-volt a-c range) across output terminals of receiver, at plug 263.	Tune receiver to resonance.	Voltmeter indication at resonance is steady. Note: If all indications in this step are normal, the receiver is O.K. and no further checks are necessary.	LINE jack 262-2.
Audio-Amplifier Circuit					
9 (Part 1)	Ⓒ Pin 4 of detector-a.v.c.-1st audio amplifier tube.	Apply weak 1000-cycle signal from audio-frequency signal generator to test point.	No change.	Undistorted 1000-cycle tone heard in headset.	Trouble in audio-frequency-amplifier circuit; to locate trouble, proceed with steps 10 and 11.
9 (Part 2)			Vary AUDIO GAIN INCREASE control from maximum to minimum.	Volume of sound in headset decreases smoothly as control is rotated.	AUDIO GAIN INCREASE control 251.
9 (Part 3)			Set AUDIO GAIN INCREASE control to maximum. Set ATTENUATION control to —6DB, and then to —12 DB.	Volume of sound in headset decreases for each setting of ATTENUATION control.	ATTENUATION control 254.
9 (Part 4)		Connect multimeter (100-volt a-c range) across output terminals of receiver, at plug 263.	Set ATTENUATION control to 0 DB.	Voltmeter indication is steady. Note: If all indications in this step are normal, the audio-frequency-amplifier circuit is O.K., and no further checks on this circuit are necessary.	LINE jack 262-2.

TEST-POINT-CHECK CHART
RADIO RECEIVER (Continued)
Audio-Amplifier Circuit (Continued)

STEP	TEST POINT	TEST-EQUIPMENT INSTRUCTIONS	RECEIVING EQUIPMENT INSTRUCTIONS	NORMAL INDICATION	POSSIBLE CAUSE OF ABNORMAL INDICATION
10	C1 Pin 5 of 2nd audio amplifier tube 6K6.	Apply strong 1000-cycle signal from audio-frequency signal generator to test point.	Set AUDIO GAIN INCREASE control to maximum. Set ATTENUATION control to 0 DB.	Undistorted 1000-cycle tone heard in headset.	2nd audio-amplifier tube (6K6) VT-152 or associated components.
11 (Part 1)	C Pin 4 of detector-a.v.c.-1st audio amplifier tube.	Apply weak 1000-cycle signal from audio-frequency signal generator to test point.	No change.	Same as step 10.	Detector-a.v.c.-1st audio amplifier tube (6SQ7) VT-103 or associated components.
11 (Part 2)		Same as step 9, part 2.	Same as step 9, part 2.	Same as step 9, part 2.	Same as step 9, part 2.
11 (Part 3)		Same as step 9, part 3.	Same as step 9, part 3.	Same as step 9, part 3.	Same as step 9, part 3.
11 (Part 4)		Same as step 9, part 4.	Same as step 9, part 4.	Same as step 9, part 4.	Same as step 9, part 4.

Intermediate-Frequency Circuits

12 (Part 1)	D Pin 1 of mixer tube.	Disconnect audio-frequency signal generator and multimeter from receiver. Connect output of r-f signal generator through .1-uf. capacitor to test point. Adjust generator for weak, modulated output at 12 mc.	No change.	Loud, clear tone heard in headset.	Trouble in i-f amplifier circuit; to locate trouble proceed with steps 13 through 17.
12 (Part 2)				TUNING METER indicates 5 ma.	Improperly set THRESHOLD SENSITIVITY control. Trouble in cathode-circuit components of i-f-amplifier stages.
12 (Part 3)		Adjust r-f signal generator for a modulated 12,070-kc. output signal, then for a modulated 11,930-kc. output signal.		Amplitude of 1000-cycle tone in head-set is approximately the same at both frequencies. Note: If all indications in this step are normal, the i-f amplifier circuit is O.K., and no further checks on this circuit are necessary.	Improper alignment. See alignment procedure (Experiment No. 10).
13	D1 Pin 4 of detector tube.	Connect r-f signal generator to test point and adjust for strong 12 mc. output.	No change.	Clear tone heard in headset.	Detector-a.v.c.-1st audio amplifier tube VT-103 (6SQ7) or associated components.
14	D2 Pin 4 of 3rd i-f-amplifier tube.	Same as step 13.	No change.	Clear tone, louder than in step 13, heard in headset, if normal, decrease generator output until sound in headset is about the same level as in step 13, proceed with next step.	3rd i-f amplifier tube VT-211 (6SQ7) or associated components. Stage alignment.

TEST-POINT-CHECK CHART
RADIO RECEIVER (Continued)
Intermediate-Frequency Circuits (Continued)

STEP	TEST POINT	TEST-EQUIPMENT INSTRUCTIONS	RECEIVING EQUIPMENT INSTRUCTIONS	NORMAL INDICATION	POSSIBLE CAUSE OF ABNORMAL INDICATION
15	D3 Pin 4 of 2nd i-f-amplifier tube.	Connect r-f signal generator to test point.	No change.	Same as step 14.	2nd i-f-amplifier tube VT-211 (6SG7) or associated components. Stage alignment.
16 (Part 1)	D4 Pin 4 of 1st i-f-amplifier tube.	Connect r-f signal generator to test point.	No change.	Same as step 14.	1st i-f-amplifier tube VT-211 (6SG7) or associated components. Stage alignment.
16 (Part 2)				TUNING METER indicates 5 ma.	Improperly set THRESHOLD SENSITIVITY control. Trouble in cathode-circuit components of i-f-amplifier stages.
17 (Part 1)	D Pin 1 of mixer tube.	Connect r-f signal generator to test point.	No change.	Clear tone, louder than in step 13, heard in headset.	Mixer tube VT-203 (9003) or associated components. Stage alignment.
17 (Part 2)		Adjust r-f signal generator for a modulated 12,070-kc. output signal, then for a modulated 11,930-kc. output signal.		Amplitude of tone in headset is approximately the same at both frequencies.	Improper alignment. See alignment procedure (Experiment No. 10).

H-F Oscillator and Doubler Circuits

STEP	TEST POINT	TEST-EQUIPMENT INSTRUCTIONS	RECEIVING EQUIPMENT INSTRUCTIONS	NORMAL INDICATION	POSSIBLE CAUSE OF ABNORMAL INDICATION
18	E Pin 5 of r-f-amplifier tube.	Disconnect r-f signal generator from receiver. Connect bare end of r-f pick-up wire to plate side of r-f coil at test point. Set STAND BY-OPERATE switch on frequency meter to OPERATE.	Remove r-f amplifier tube. Tune receiver to frequency of frequency meter.	Loud, clear, 1000-cycle tone heard in headset. Note: If indication is normal, the h-f-oscillator, doubler, and mixer circuits are O.K., and no further checks on these circuits are necessary.	Trouble in h-f-oscillator, doubler or mixer circuit; to locate trouble, proceed with steps 19 and 20.
19	E1 Pin 6 of h-f-oscillator tube.	Connect negative lead of multimeter (30-volt d-c range) in series with an r-f choke to test point. Connect positive lead to chassis.	No change.	Approximately 5 volts.	H-f-oscillator tube VT-202 (9002) or associated components.
20	E Pin 5 of r-f-amplifier tube.	Disconnect multimeter from receiver. Same as step 18.	Same as step 18.	Loud, clear, 1000-cycle tone heard in headset.	Capacitor 224. Doubler tube VT-203 (9003) or associated components. Mixer tube VT-203 (9003) or associated components.

TEST-POINT-CHECK CHART
RADIO RECEIVER (Continued)
Radio-Frequency Circuit

STEP	TEST POINT	TEST-EQUIPMENT INSTRUCTIONS	RECEIVING EQUIPMENT INSTRUCTIONS	NORMAL INDICATION	POSSIBLE CAUSE OF ABNORMAL INDICATION
21 (Part 1)	F Antenna-coupling socket.	Disconnect r-f pick-wire from r-f coil. Set STAND BY-OPERATE switch on frequency meter to OPERATE, and OUTPUT CONTROL to MIN.	Replace r-f amplifier tube. Tune receiver to frequency of frequency meter (130 mc.)	Loud, clear, 1000-cycle tone heard in headset.	R-f-amplifier tube VT-203 (9003) or associated components.
21 (Part 2)			Vary R.F. GAIN INCREASE control from maximum to minimum.	TUNING METER indication and sound in headset decrease smoothly as control is rotated.	R.F. GAIN INCREASE control 242. Trouble in cathode-circuit components of i-f-amplifier or r-f amplifier stages.
C-W-Oscillator Circuit					
22	G Antenna-coupling socket.	Same as step 21.	Set R.F. GAIN INCREASE control to maximum. Set C.W. AND MANUAL-MANUAL - A.V.C. switch to C.W. AND MANUAL. Vary C.W. TONE CONTROL through its range.	Beat note which varies with position of C.W. TONE CONTROL is superimposed on 1000-cycle tone heard in headset.	C-w-oscillator tube VT-211 (6SG7) or associated components.
A-V-C Circuit					
23	H TUNING METER	Same as step 21 except set OUTPUT CONTROL to MAX.	Set C.W. AND MANUAL - MANUAL-A.V.C. switch to A.V.C. Tune receiver through resonance.	TUNING METER indication dips to a low value as receiver is tuned through resonance. Undistorted tone is heard in headset at resonance.	Detector-a.v.c.-1st audio amplifier tube VT-103 (6SQ7). Resistor 244-1 or 244-2. Capacitor 215-2 or 230-16. Switch 243. Trouble in a-v-c voltage-distribution circuit.

LESSON PLAN No. 15

TIME ALLOTTED: 2 HR.

SUBJECT

Philco method of trouble-shooting Radio Receiver BC-639-A.

OBJECTIVE

To familiarize the trainee with a logical, systematic trouble-shooting procedure.

INTRODUCTION

Checks which determine the condition of individual circuits are made at designated test points, as outlined in previous lectures and experiments. By making these checks in the proper order, the source of equipment trouble may be easily located.

SUBJECT MATERIAL

1. Advantages of a systematic trouble-shooting procedure.
2. Outline of Philco Trouble-Shooting Procedure.
3. Importance of operational checks.
4. Preliminary preparations for operational checks.
5. Operational checks.
6. Need for test-point checks.
7. Preliminary preparations for test-point checks.
    a. Equipment required.
    b. Preparing the receiver.
    c. Preparing the frequency meter.
    d. Preparing the signal generators.
8. Test-point checks.
    a. Power-supply checks.
    b. Radio-receiver checks.

CONCLUSIONS

The use of a logical trouble-shooting procedure, such as the Philco Trouble-Shooting Procedure, eliminates guesswork and enables the technician to locate equipment troubles quickly and efficiently.

ORAL QUIZ

1. What are two advantages of using a logical, systematic method of trouble shooting?

2. When a receiver has trouble, what is the first thing that should be done in determining the cause of trouble?

3. What are the three basic steps of the Philco Trouble-Shooting Procedure?

4. What is the purpose of an operational check?

5. What is the purpose of tests at major test points? At key test points? At secondary test points?

6. After trouble is localized and isolated, what method is used to locate the defective part?

7. Why must the operational checks be performed in proper sequence? The test-point checks?

8. What major test point is used to check the power-supply circuit? The receiver?

9. Is it possible to locate equipment trouble without the use of test equipment?

10. Does the Philco Trouble-Shooting Procedure deal with physical units or with functional units?

EXPERIMENT No. 12

TIME ALLOTTED: 2 HR.

SUBJECT

Trouble shooting.

OBJECTIVE

To become familiar with a logical, systematic method of trouble shooting Radio Receiver BC-639-A.

EQUIPMENT REQUIRED

1 Radio Receiver BC-639-A.
1 Rectifier Unit RA-42-B.
1 Power-supply cable equipped with two Jones connector sockets.
1 Frequency Meter BC-638-A.
1 A-f signal generator.
1 R-f signal generator, internally modulated (preferably at 1000 cycles), with a frequency range which includes 12 mc.
1 Multimeter (20,000 ohms per volt), with a-c and d-c ranges which include 750-volt and 30-volt ranges.
1 R-f choke.
1 600-ohm, two-watt carbon resistor.
2 Headsets.
1 R-f pickup wire (5-inch length of No. 18 A.W.G. hookup wire).

INSTRUCTIONS

Remove the receiver and power-supply chassis from their dust covers. Prepare the test instruments for use in trouble shooting the receiver and power supply, then wait until the instructor gives the signal to start.

PROCEDURE

The receiver has a trouble, or a number of troubles, placed in it by the instructor. Using the trouble-shooting method outlined in the lecture on trouble shooting, and the information given in previous experiments and lectures, locate and correct all of the troubles in the equipment. Prepare a list of the troubles, and state how each trouble was corrected. Give this list to the instructor.

CONCLUSIONS

1. Could the troubles which were placed in the receiver be located as quickly without using a systematic trouble-shooting procedure? Why?

2. Why were some troubles more difficult to locate than others?

3. When a trouble was finally isolated to a single stage, what tests were used to locate the defective part?

4. If the secondary coil of the 1st i-f transformer is open, how many test-point checks must be performed to isolate the trouble? To locate the defect?

FINAL REVIEW

This review requires about four hours, and is to be conducted in the form of an oral quiz. Display both the block and schematic diagrams, and review the important points contained in Lectures No. 10 through No. 15 and Experiments No. 7 through No. 12, by asking the questions contained in the Oral Quiz of each Lesson Plan and in the Conclusions of each Experiment. If any question causes the students difficulty, be sure to explain the answer fully. At regular intervals during the review, permit the students to ask questions of their own pertaining to the subject material. Make a note of each question on which the students indicate a general weakness.

Referring to the notes made during both this review and the previous review, thoroughly discuss the questions which have caused general difficulty throughout the course.

FINAL EXAMINATION

This examination covers the material contained in this course. The normal time allotment for Parts I and II of the examination is approximately two hours, and for Part III approximately one hour.

No reference material is necessary for Part I. After Part I is finished, wait for the instructor to collect the papers. Do not start Part II until directed to do so by the instructor. The schematic and block diagram may be used in answering the questions contained in Part II of the examination.

Part III is a trouble-shooting examination and will be conducted in the laboratory.

PART I

MULTIPLE-CHOICE QUESTIONS

1. Very high frequencies when used for communication purposes:

a. provide a long transmission range since the v-h-f signals follow the curvature of the earth.

b. make it possible to cover a wider area with the transmitted signal than is covered with low-frequency signals.

c. are reliable under varying conditions of the ionosphere and atmospheric static.

d. minimize the possibility of interference caused by reflected signals.

2. The half-wave dipole antenna, which is generally used with the BC-639-A, is connected to the receiver by means of a :

a. twisted 300-ohm line.

b. 600-ohm parallel line.

c. waveguide.

d. 70-ohm coaxial line.

3. The power requirements of Radio Receiver BC-639-A are:

a. 6.3 volts, a.c. or d.c., at 3.5 amperes and 210 volts, d.c., at milliamperes.

b. 2.5 volts, a.c. or d.c., at 4 amperes and 180 volts, d.c., at 80 milliamperes.

c. 12 volts, d.c., at 2 amperes and 400 volts, d.c., at 60 milliamperes.

d. 24 volts, d.c., at 2 amperes and 220 volts, a.c., at 70 milliamperes.

4. The power required to operate Radio Receiver BC-639-A is generally furnished by:

a. batteries.

b. a built-in power supply.

c. a motor-generator.

d. an external power supply.

5. The THRESHOLD SENSITIVITY control is normally set for a TUNING METER reading of:

a. 2 ma.

b. 20 ma.

c. 10 ma.

d. 5 ma.

6. The intermediate frequency used in Radio Receiver BC-639-A is:

a. 12 mc.

b. 22 mc.

c. 6 mc.

d. 455 kc.

7. The two signals which are introduced into the mixer circuit to produce the intermediate frequency are:

a. the incoming v-h-f signal and the signal produced by the beat-frequency (c-w) oscillator circuit.

b. the signal produced by the beat-frequency (c-w) oscillator circuit and a 1000-cycle signal from the audio-amplifier circuit.

c. The incoming v-h-f signal and a locally generated v-h-f signal which is 12 mc. lower in frequency than the incoming signal.

d. the beat-frequency (c-w) oscillator signal and the signal generated by the h-f oscillator circuit.

8. The 1st and 2nd i-f transformers have a:

a. narrow (10-kc.) frequency-response characteristic.

b. wide (300-kc.) frequency-response characteristic.

c. double-humped frequency-response characteristic with peaks occurring 70 kc. each side of the resonant frequency.

d. double-humped frequency-response characteristic with peaks occurring 10 kc. each side of the resonant frequency.

9. The operation of the a-v-c circuit may be best checked by noting the:

a. TUNING METER indications.

b. output-meter indication.

c. setting of the R.F. GAIN INCREASE control.

d. intensity of sound in the headset.

10. The output of the audio amplifier is greatest at frequencies between:

a. 200 and 600 cycles.

b. 600 and 2500 cycles.

c. 2500 and 5000 cycles.

d. 5000 and 10,000 cycles.

11. The output impedance of the audio amplifier is properly matched by a load impedance of:

a. 600 ohms.

b. 100 ohms.

c. 20 ohms.

d. 50,000 ohms.

12. When the output of the receiver is fed directly into a telephone-line circuit, the telephone line is normally connected to:

a. LINE jack.

b. binding posts marked OUTPUT.

c. MONITOR jack.

d. Terminals 11 and 12 of power-supply plug 263.

13. What happens when a headset is plugged into the LINE jack on the receiver panel?

a. the telephone line is disconnected from the receiver output.

b. the telephone line is connected to the receiver output.

c. the receiver is disabled.

d. the headset is connected in parallel with the telephone line.

14. With the receiver connected the d-c output voltage of the power supply is 210 volts; with the receiver disconnected the output voltage of the power supply is approximately:

a. 600 volts.

b. 210 volts.

c. 350 volts.

d. 140 volts.

15. In the over-all receiver alignment several alignment procedures are involved; the order in which they are normally performed is:

a. i-f-amplifier alignment; beat-frequency (c-w) oscillator alignment; tuning-mechanism adjustment; h-f-oscillator, doubler, mixer, and r-f amplifier alignment.

b. i-f amplifier alignment; h-f-oscillator, doubler, mixer, and r-f-amplifier alignment; tuning-mechanism adjustment; and beat-frequency (c-w) oscillator alignment.

c. h-f-oscillator, doubler, mixer, and r-f amplifier alignment; tuning-mechanism adjustment; beat-

frequency (c-w) oscillator alignment; i-f amplifier alignment.
d. beat-frequency (c-w) oscillator alignment; i-f-amplifier alignment; tuning-mechanism adjustment; h-f-oscillator, doubler, mixer, and r-f amplifier alignment.

16. The inductances of the h-f-oscillator, doubler, mixer and r-f-amplifier coils are adjusted for proper alignment at a MEGACYCLES dial setting of:
a. 100 mc.
b. 130 mc.
c. 88 mc.
d. 156 mc.

17. When the ALIGN mark on the MEGACYCLES dial is at the index on the dial window:
a. the two-gang tuning capacitor is fully meshed and the three-gang tuning capacitor is fully unmeshed.
b. the three-gang tuning capacitor is fully meshed and the two-gang tuning capacitor is fully unmeshed.
c. both the three-gang and the two-gang tuning capacitors are fully meshed.
d. both the three-gang and the two-gang tuning capacitors are fully unmeshed.

18. The over-all sensitivity of the receiver at a signal-to-noise ratio of 10 to 1 is approximately:
a. 18 microvolts.
b. 5 microvolts.
c. 75 microvolts.
d. 125 microvolts.

19. The accuracy of the dial calibration between 100 and 156 mc. should be:
a. ±1 mc.
b. ±5 mc.
c. ±10 mc.
d. ±10 kc.

20. In the trouble-shooting procedure, major test points are used to:
a. isolate the faulty circuit.
b. locate the defective part.
c. localize the trouble to a particular section.
d. align the receiver.

Essay Questions

21. Draw a block diagram of Radio Receiver BC-639-A and indicate the titles of the circuits.

22. Indicate the points on the diagram where tests should be made to check the over-all operation of the receiver, and the operation of each functional circuit in the receiver. Assign numbers to the major test points, and letters to the key test points.

23. Explain the purpose of each test point indicated on the block diagram.

24. Briefly explain how the a-v-c circuit is prevented from reducing the gain of the controlled circuits when a weak signal is being received.

25. Give the procedure for adjusting the receiver for a 10-to-1 signal-to-noise ratio.

PART II

MULTIPLE-CHOICE QUESTIONS

26. When the C.W. AND MANUAL-MANUAL-A.V.C. switch is set to the C.W. AND MANUAL position:
a. B voltage is removed from the a-v-c circuit.
b. B voltage is applied to the beat-frequency (c-w) oscillator circuit.
c. B voltage is removed from the doubler circuit.
d. B voltage is applied to both the a-v-c and detector circuits.

27. With the C.W. AND MANUAL-MANUAL-A.V.C. switch in the MANUAL position, rotation of the R.F. GAIN INCREASE control causes the TUNING METER indication to change because:
a. the voltage applied to the plate of the 1st i-f-amplifier tube is varied.
b. the voltage applied to the screen grids of all the tubes is varied.
c. the grid bias of the 1st i-f-amplifier tube is varied.
d. the filament voltage on all the tubes is varied.

28. The setting of the THRESHOLD SENSITIVITY control establishes:
a. the minimum operating bias of the mixer tube.
b. the value of plate voltage applied to the r-f and i-f amplifier tubes.
c. the level of the signals which are introduced into the mixer circuit.
d. the minimum operating bias of the i-f-amplifier tubes.

29. How many variable tuning capacitors are used in tuning the receiver from 100 to 156 mc.
a. 6.
b. 2.
c. 5.
d. 3.

30. The TUNING METER on the receiver front panel indicates:
a. the plate voltage of the 1st i-f-amplifier tube.
b. the plate current of the 1st i-f-amplifier tube.
c. the grid voltage of all the i-f-amplifier tubes.
d. the filament voltage of all the i-f-amplifier tubes.

31. In transferring the audio signal from the detector circuit into the audio-amplifier circuit, capacitor 230-17 is used as a coupling device to:
a. prevent the d-c component of the detected signal from being applied to the 1st audio-amplifier tube.
b. filter out any high intermediate frequencies which may be present in the detected signal.
c. regulate the amount of audio signal which is fed to the audio-amplifier circuit.
d. prevent power-supply hum from being introduced into the audio-amplifier circuit.

32. The beat-frequency (c-w) oscillator is coupled to:
a. the 1st i-f-amplifier stage.
b. the detector circuit.
c. the mixer circuit.
d. audio-amplifier circuit.

33. For the alignment of the i-f-amplifier circuits the signal generator is connected to:
a. the mixer-tube grid.
b. the antenna-coupling socket.
c. the r-f-amplifier plate.
d. the 1st i-f-amplifier-tube grid.

34. For the alignment of the h-f-oscillator and doubler circuits the signal generator should be connected to:

a. test point E1.
b. test point D.
c. test point F.
d. test point E.

35. If coupling capacitor 230-18 in the audio-amplifier circuit were to become shorted:

a. the receiver would be completely inoperative.
b. the receiver output would be low and distorted.
c. a constant tone would be heard in the headset connected to the receiver output.
d. the receiver would operate intermittently.

36. The operation of the audio amplifier may be checked by:

a. applying a 1000-cycle audio signal to test point D.
b. applying a 12-mc. r-f signal to test point E.
c. by applying a 1000-cycle audio signal to test point C.
d. by applying a 455-kc. r-f signal to test point C1.

37. If by-pass capacitor 239-1 in the i-f-amplifier cathode circuit were to become shorted:

a. the receiver would become inoperative.
b. the sensitivity of the receiver would be increased.
c. the selectivity of the receiver would be increased.
d. the TUNING METER indication would drop.

38. If during an operational check of the receiver the jewel indicator lamp on the power supply and the dial lamp on the receiver do not light, the first thing to check is:

a. the line cord.
b. the pilot lamps.
c. the tubes.
d. the A.C. FUSES.

39. When the voltages delivered to the receiver by the power supply are low:

a. the A.C. FUSES should be changed.
b. the filter capacitors should be replaced with capacitors having larger values.
c. the filter choke 351-2 should be shorted out.
d. the SUPPLY VOLTAGE control should be adjusted.

40. If on replacement the D.C. FUSE blows repeatedly, the following check should disclose the trouble:

a. a resistance check of the B-voltage-supply filter.
b. a resistance check of the power-transformer primary.
c. a voltage check of the rectifier-tube output.
d. a voltage check of the power-transformer secondary windings.

41. If cathode by-pass capacitor 230-8 of the 2nd i-f amplifier tube were to become shorted with the C.W. AND MANUAL-MANUAL-A.V.C. switch in the MANUAL position:

a. the R.F. GAIN INCREASE control would operate normally in controlling the receiver sensitivity.
b. the a-v-c circuit would be disabled and would have no control of the receiver sensitivity.
c. the a-v-c bias to the 2nd i-f-amplifier tube would be shorted out.
d. the R.F. GAIN INCREASE control would have little or no effect upon the receiver sensitivity.

42. If the receiver operates normally but no beat note is heard in the headset upon rotation of the C.W. TONE CONTROL except at one point where a high-pitched note is heard, the first thing to check is:

a. the beat-frequency (c-w) oscillator plate-by-pass capacitor 230-19.
b. the beat-frequency (c-w) oscillator alignment.
c. the beat-frequency (c-w) oscillator coupling capacitor 267.
d. the detector tube.

43. When no sound is heard over the telephone line connected to the receiver but normal sound is heard in the headset plugged into the MONITOR jack, the trouble is probably caused by a defective:

a. LINE jack.
b. MONITOR jack.
c. 2nd audio-amplifier tube.
d. output transformer.

44. With the C.W. AND MANUAL-MANUAL-A.V.C. switch in the MANUAL position a great change in the TUNING METER reading is noted when a strong signal is tuned in. The probable cause of trouble is:

a. an open THRESHOLD SENSITIVITY control.
b. an open a-v-c load resistor.
c. a defective C.W. AND MANUAL-MANUAL-A.V.C. switch.
d. an open R.F. GAIN INCREASE control.

45. The a-v-c filter capacitor 230-16 is shorted and the C.W. AND MANUAL-MANUAL-A.V.C. switch is set to the A.V.C. position. As a strong signal is tuned in on the receiver the TUNING METER reading will:

a. rise sharply.
b. dip sharply.
c. fall to zero.
d. show little or no change.

Essay Questions

46. Explain in detail how the a-v-c voltage is produced.

47. Give the purpose of resistor 244-2 and capacitor 230-16 in the a-v-c circuit.

48. Give the purpose of capacitor 230-19 and resistor 264 in the beat-frequency (c-w) oscillator circuit.

49. Briefly describe what must be done to Rectifier Unit RA-42-B when shifting operation from a 110-volt power source to a 220-volt power source.

50. Give the complete step-by-step procedure for locating a defective (open) output filter choke in the power-supply circuit.

T.O. 31R2-3BC639-22
(Formerly 31R2-3SCR574-42)

HANDBOOK
MAINTENANCE INSTRUCTIONS

RADIO RECEIVER
BC-639-A

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LATEST REVISED PAGES SUPERSEDE THE SAME PAGES OF PREVIOUS DATE

Insert revised pages into basic publication. Destroy superseded pages.

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UNSATISFACTORY REPORT

FOR U. S. ARMY AIR FORCE PERSONNEL:

In the event of malfunctioning, unsatisfactory design, or unsatisfactory installation of any of the component units of this equipment, or if the material contained in this book is considered inadequate or erroneous, an Unsatisfactory Report, AAF Form No. 54, or a report in similar form shall be submitted in accordance with the provisions of Army Air Force Regulation No. 15-54, listing:

1. Station and organization.
2. Nameplate data (type number or complete nomenclature if nameplate is not attached to the equipment).
3. Date and nature of failure.
4. Airplane model and serial number.
5. Remedy used or proposed to prevent recurrence.
6. Handbook errors or inadequacies, if applicable.

FOR U. S. NAVY PERSONNEL:

Report of failure of any part of this equipment during its guaranteed life shall be made on Form N. Aer. 4112 "Report of Unsatisfactory or Defective Material" or a report in similar form and forwarded in accordance with the latest instructions of the Bureau of Aeronautics. In addition to other distribution required, one copy shall be furnished to the inspector of Naval Material (location to be specified) and the Bureau of Ships. Such reports of failure shall include:

1. Reporting Activity.
2. Nameplate data.
3. Date placed in service.
4. Part which failed.
5. Nature and cause of failure.
6. Replacement needed (yes-no).
7. Remedy used or proposed to prevent recurrence.

FOR BRITISH PERSONNEL:

Form 1022 procedure shall be used when reporting failure of radio equipment.

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DESTRUCTION OF ABANDONED MATERIEL IN THE COMBAT ZONE

In case it should become necessary to prevent the capture of this equipment and when ordered to do so, DESTROY IT SO THAT NO PART OF IT CAN BE SALVAGED, RECOGNIZED OR USED BY THE ENEMY. BURN ALL PAPERS AND BOOKS.

Means:—

1. Explosives, when provided.
2. Hammers, axes, sledges or whatever heavy object is readily available.
3. Burning by means of incendiaries such as gasoline, oil, paper or wood.
4. Grenades and shots from available arms.
5. Where possible, and when time permits, bury all debris or dispose of it in streams or other bodies of water.

Procedure:—

1. Obliterate all identifying marks. Destroy nameplates and circuit labels.
2. Demolish all panels, castings, switch-and instrument-boards.
3. Destroy all controls, switches, relays, connections and meters.
4. Rip out all wiring in electrical equipment. Smash gas, oil and water cooling systems in gas-engine generators, etc.
5. Smash every electrical or mechanical part whether rotating, moving or fixed.
6. Break up all operating instruments such as keys, phones, microphones, etc.
7. Destroy all classes of carrying cases, straps, and containers, etc.

SPECIAL NOTICE

The most common fault with field radio equipment is loose or bad connections. Look for this *first*. The second most common repair needed is from bad adjustments by unqualified operating personnel. There are almost no internal adjustments or repairs you should do on this unit. Use a spare unit when you can get it and send for your experienced repairman. His experience and equipment will save the extra time.

A WRONG INTERNAL ADJUSTMENT ON EQUIPMENT OPERATING AT THESE FREQUENCIES MAY MAKE IT NEED A FACTORY REPAIR JOB WHILE A SIMPLE REPAIR JOB WOULD HAVE BEEN ENOUGH.

SAFETY NOTICE

THIS EQUIPMENT USES HIGH VOLTAGES WHICH ARE DANGEROUS TO LIFE. YOU MUST ALWAYS OBSERVE ALL SAFETY RULES.

FIRST AID

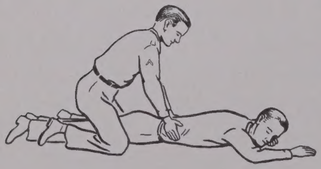
PERSONNEL ENGAGED IN INSTALLING, OPERATING AND REPAIRING THIS OR SIMILAR EQUIPMENT MUST KNOW THESE RULES. EVERY RADIOMAN MUST BE READY TO GIVE FIRST AID AND SO PREVENT AVOIDABLE LOSS OF LIFE. YOUR LIFE MAY DEPEND ON THIS.

Do These Three Things First in Any Emergency

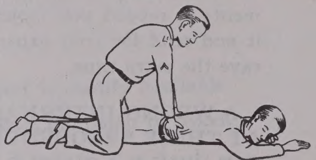
1. Send for a doctor or carry the victim to a doctor.
2. Keep victim warm, quiet and flat on his back.
3. If breathing has stopped apply artificial respiration. Stop all serious bleeding.

THE PRONE PRESSURE METHOD OF ARTIFICIAL RESPIRATION IF DUE TO ELECTRIC SHOCK

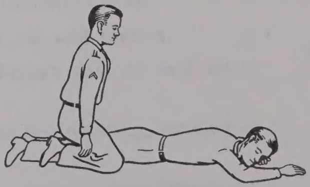
1. **PROTECT YOURSELF** with **DRY** insulating material.
2. **BREAK THE CIRCUIT** by opening the power switch or pulling the victim free of the live conductor. **DON'T** touch **VICTIM WITH YOUR BARE HANDS UNTIL CIRCUIT IS BROKEN.**
3. **SPREAD DRY BLANKET ON THE GROUND,** and roll victim to center of blanket with his arms above his head, so that he lies **FACE DOWN** on blanket.
4. **BEND ONE OF THE VICTIM'S ARMS** at the elbow and rest victim's cheek on the back of his hand.
5. **REMOVE FALSE TEETH,** gum, candy, tobacco, food, etc., from his mouth.
6. **LOOSEN ALL TIGHT CLOTHING,** as belts or collars.
7. **COVER VICTIM LOOSELY** by wrapping the ends of blanket around him.
8. **STRADDLE VICTIM'S** thighs.
9. **PUT YOUR PALMS ON VICTIM'S BACK** so that the little fingers of each hand just touch victim's lowest ribs.



10. **KEEP YOUR ARMS STIFF AND STRAIGHT** and swing your body forward, let your weight bear down on him.



11. **DO NOT PUSH OR USE FORCE.**
12. **SWING BACK AT ONCE TO RELIEVE** pressure.



13. **KEEP REPEATING.**
14. Keep this up with steady rhythm until victim regains consciousness or is pronounced dead by doctor.
15. **CONTINUE ARTIFICIAL RESPIRATION** even after victim begins to breathe, and until he becomes conscious.

16. IF BREATHING STOPS AGAIN, continue artificial respiration at once.
17. DO NOT GIVE UP HOPE. Four hours or more of steady artificial respiration may be needed before he comes to.
18. NEVER TRY TO FORCE LIQUIDS down an unconscious person's throat. He will drown.
19. ALWAYS WAIT UNTIL CONSCIOUSNESS RETURNS before giving liquid stimulants.
20. STIMULANTS THAT CAN BE USED ARE: Hot black coffee. Strong hot tea. Aromatic spirits of ammonia, (one teaspoonful to a glass of water).
21. GIVE ONLY ONE STIMULANT, which should be sipped slowly.
22. Don't give ALCOHOLIC DRINKS, not good unless absolutely necessary.
23. WHEN VICTIM HAS RETURNED TO CONSCIOUSNESS, let him lie quietly where he is for at least one hour, see that he is well covered and has no worry.
24. IF YOU CAN, CARRY HIM TO A DOCTOR.

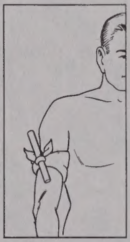
WOUNDS

Neglected wounds can have serious results. Any break in the skin is a wound. Paint small cuts and scratches at once with TINCTURE OF IODINE. Keep cuts and wounds CLEAN but DO NOT use Tincture of Iodine on them. Wash AROUND and AWAY FROM the wound with ordinary soap and water, if no other antiseptic is at hand. Other antiseptics for deep wounds are: Violet gentian, Potassium permanganate, Tincture of Merthiolate, or ordinary baking soda and water. Cover the wound with a sterile gauze dressing and hold in place with adhesive tape or a strip of gauze.

In cases of serious bleeding, when an artery has been cut, firm pressure is necessary to stop the flow of blood. Artery blood is BRIGHT RED and comes in SPURTS, with each heart beat. Blood from a vein is DARK RED and flows steadily. Pressure is not often needed for venous bleeding.

Pressure is applied between the WOUND AND THE HEART, to stop ARTERIAL BLEEDING. Apply pressure BELOW the wound, or AWAY FROM THE HEART to stop BLEEDING VEINS.

Pressure is best applied and maintained by means of a strip of cloth, bandage, tied ABOVE the wound. Tie a simple, double knot in the cloth and put a strong stick in the loop then tighten the knot by pulling the ends of the cloth. With stick held firmly in place, twist it, until bleeding stops.



DO NOT keep pressure on longer than 15 minutes at a time.

IF BLEEDING CONTINUES after taking off pressure, allow blood to flow for 30 to 60 seconds and then re-apply pressure. Continue until bleeding stops.

AFTER BLEEDING HAS STOPPED, cover wound with a sterile dressing. DON'T TOUCH WOUND OR DRESSING WITH DIRTY HANDS!

Keep victim FLAT ON HIS BACK, AND WELL COVERED. DON'T LET HIM SEE HIS WOUND. Keep his thoughts from himself.

Get a DOCTOR AS SOON AS YOU CAN.

BURNS

Burns from contact with high voltage electricity, fire, or friction, need care at once.

1. Apply AT ONCE any one of these liberally:—
    a. Tannic acid jelly.
    b. Butesin picrate.
    c. Paste made with baking soda and water.
    d. Very strong, cool tea.
2. Cover with STERILE GAUZE.
3. If clothing sticks to burn, DON'T REMOVE IT.
4. Keep victim WELL COVERED and FLAT ON HIS BACK. Soothe and reassure him.
5. GET A DOCTOR AS SOON AS YOU CAN.

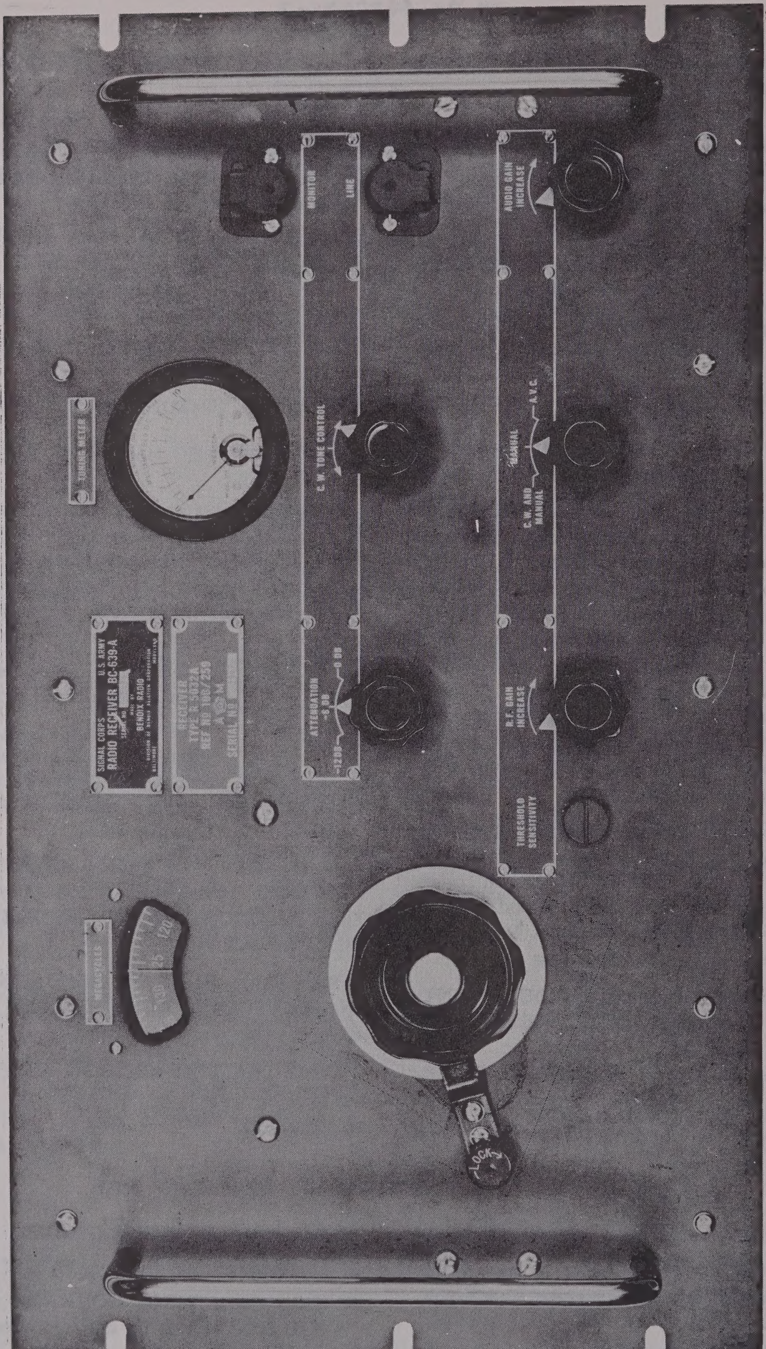

MONITOR
LINE
AUDIO GAIN INCREASE
TUNING METER
C.W. TONE CONTROL
MANUAL
A.V.C.
C.W. AND MANUAL
SIGNAL CORPS U.S. ARMY
RADIO RECEIVER BC-639-A
BENDIX RADIO
RECEIVER
ATTENUATION
-120 DB
0 DB
R.F. GAIN INCREASE
THRESHOLD SENSITIVITY
MEGACYCLES
LOCK

Figure 1 — Radio Receiver BC-639-A, Front View

SECTION I

GENERAL DESCRIPTION

1. GENERAL.

a. Radio Receiver BC-639-A is a superheterodyne receiver. It receives both radiophone communication and direction-finding signals from aircraft.

The entire receiver unit is mounted on a shelf type chassis and all of the components are supported from the front panel. The receiver is used for standard rack mounting in ground stations. The chassis has a dust proof cover which is held securely in place by fifteen binder-head screws.

Since the heat (power) given off by the receiver is small, ventilating louvers are left out, and the receiver is dust proof.

Radio Receiver BC-639-A receives amplitude modulated or c-w radio signals on the ultra-high frequency band from 100 to 156 megacycles (1.92 to 3 meters). Its slow-motion drive dial gives complete frequency coverage without switching.

The receiver consists of:

(1) A radio frequency amplifier stage

(2) An oscillator stage

(3) A doubler stage

(4) A mixer stage

(5) Three intermediate frequency amplifier stages, using an intermediate frequency of 12 megacycles

(6) A second detector stage

(7) A first audio stage (combined in a single tube with the 2nd detector stage)

(8) An audio output amplifier stage

(9) A beat frequency oscillator which feeds into the second detector and can be switched into the circuit when needed.

The beat frequency oscillator is used for taking D/F bearings on an unmodulated carrier and for the reception of c-w telegraph signals. The receiver has good automatic volume control and good frequency stability. It will function for a long time without frequent monitoring. A manual volume control is used in taking bearings for D/F service.

The power supply is not built into the receiver but a cable which plugs into the rear of the chassis connects the receiver to the separate power supply.

The audio frequency response of Radio Receiver BC-639-A gives greatest clearness to speech signals. The response is practically flat from 600 to 3000 cycles, but it is 10 db down at 200 cycles. The frequencies above 3000 cycles, are also attenuated and the response is 10 db down at 5000 cycles.

The output of the receiver is connected to two terminals of socket 263 which is at the rear of the chassis. Socket 263 is a six-contact socket through which all outside connections are made to Radio Receiver BC-639-A, (except for the antenna) by means of a power supply cable and Jones plug connection. The output of the receiver feeds directly into a telephone line system, the output impedance having been chosen to satisfy this requirement. The output transformer has a balanced output and an electrostatic shield between the windings so the receiver output circuit is suitable for direct connection to the telephone line circuit. Provisions for Loudspeaker LS-3 operation is provided. Two telephone jacks are on the front panel; the one marked MONITOR, is used for monitoring the receiver at any time, the other, marked LINE, is wired so that when a plug is put into it, the output of the receiver is disconnected from socket 263 at the rear of the unit by opening both sides of the output circuit and will be heard only in the headset plugged into the LINE and MONITOR jack. The receiver works into a 600-ohm load, but good operation will be had when operating into any load between 200 and 20,000-ohms.

b. **FRONT PANEL.**—The front panel of Radio Receiver BC-639-A has the following controls, indicators and receptacles: (fig. 1)

(1) TUNING CONTROL.—The tuning control is a slow motion drive dial. It is on the left side of the panel. The control drives the five tuning capacitors for a complete coverage of the frequency band (100-156 megacycles). The dial is calibrated directly in megacycles and the scale moves behind a window just above the control knob. A dial light (6-8 volt, .25 ampere, bayonet base bulb, Mazda #44) indirectly lights the scale.

(2) SENSITIVITY CONTROL.—At the bottom of the panel and to the left of a row of three control knobs is a screw cap which covers the THRESHOLD SENSITIVITY control. This control

is a slotted shaft for screwdriver adjustment. It is covered by a screw cap which you must remove (by hand) before you can adjust it. This control is used to set the maximum gain of the receiver and when you have once set it at a particular place you should not change it.

(3) R.F. GAIN INCREASE CONTROL.—Next to the THRESHOLD SENSITIVITY control is the R.F. GAIN INCREASE control knob which controls the radio frequency sensitivity of the receiver. An arrow on the plate above this knob shows the direction to turn the control for an increase in r-f gain.

(4) C.W. AND MANUAL, MANUAL, A.V.C. SWITCH.—The third control is a three-position switch marked C.W. AND MANUAL, MANUAL, A.V.C.

(*a*) The C.W. AND MANUAL position is for receiving unmodulated signals with manual control of the volume;

(*b*) The MANUAL position is used for receiving modulated signals with manual control of the volume;

(*c*) The A.V.C. position is for receiving modulated signals with automatic volume control.

(5) AUDIO GAIN INCREASE.—The last control on the lower right hand side of the panel is the AUDIO GAIN INCREASE which controls the output volume. It has an arrow marking the direction of increase.

(6) ATTENUATION SWITCH.—At the center of the front panel and to the right of the tuning control, is a three-position switch marked ATTENUATION. This switch has three positions marked —12 DB, —6 DB, 0 DB. This switch gives different maximum power outputs.

(7) C.W. TONE CONTROL.—The second control knob is the C.W. TONE CONTROL which varies the beat note when receiving unmodulated signals.

(8) MONITOR JACK AND LINE JACK. The two output jacks are on the right side of the panel, and are marked MONITOR and LINE. Putting a headphone plug into the MONITOR jack will place the headphones across the line without interrupting the circuit. Inserting the headphone plug into the LINE jack places the headphones across the receiver output which is then disconnected from the line.

(9) TUNING METER.—The TUNING METER is at the top of the front panel. It shows the current drawn by the first intermediate frequency amplifier Tube VT-211. When the C.W. AND MANUAL, MANUAL, A.V.C. switch is at A.V.C., it is used in tuning the receiver to exact resonance.

NOTE

All Radio Receivers BC-639-A, with serial numbers higher than No. 2595, have a dial lock and jack covers.

2. COMPONENTS

Description	*Overall size in inches (Including projections)*	*Weight in lbs.*	*Sig. C. Stock No.*
1 Radio Receiver BC-639-A (complete with tubes)	19 x $10\frac{15}{32}$ x $13\frac{9}{16}$	38	2C4439A
Radio Receiver BC-639-A uses either of following two power supplies:—			
1 Rectifier RA-42-A,	19 x $6\frac{31}{32}$ x $8\frac{23}{32}$	26	3H4682A
Rectifier RA-42-B	19 x $6\frac{31}{32}$ x $8\frac{23}{32}$	26	3H4682B
or			
1 Dynamotor Unit PE-100-A	19 x $10\frac{15}{32}$ x $8\frac{11}{16}$	24	6D7800T100A
1 Case CS-134	10 x $10\frac{1}{2}$ x 12	11	6D7400T639A
2 AN 08-10-216, Handbook of Maintenance Instructions for Radio Receiver BC-639-A	$8\frac{1}{2}$ x 11		

Both power supplies are described in separate instruction books;

TUBE COMPLEMENT.

Quantity	*Mfr. Type*	*Name*	*Signal Corps Type*
1	6SQ7	Duplex-diode high-mu triode	VT-103
1	6K6-GT/G	Power amplifier pentode	VT-152
1	9002	Triode	VT-202
3	9003	Semi-remote cut-off pentode	VT-203
4	6SG7	Remote cut-off pentode	VT-211

3. ANTENNA REQUIREMENTS.

a. The antenna input to Radio Receiver BC-639-A works in conjunction with a 70-ohm coaxial cable which has the outside grounded; however, good results will be obtained with anything from 20 to 100 ohms. You will get the best results by using a ½ wave dipole antenna placed as high as possible, and connected to the receiver by means of a 70-ohm coaxial transmission line. Connections are made to a special coaxial antenna socket at the rear of the receiver chassis.

4. POWER REQUIREMENTS.

a. The power input to the receiver from the power supply unit is as follows:

210 volts direct current, (180 volts minimum, 240 volts maximum). Current drain 60 milliamperes at 210 volts.

6.3 volts, 3.5 amperes, alternating current or direct current.

In an installation where both Rectifier RA-42-A, (or Rectifier RA-42-B) and Dynamotor Unit

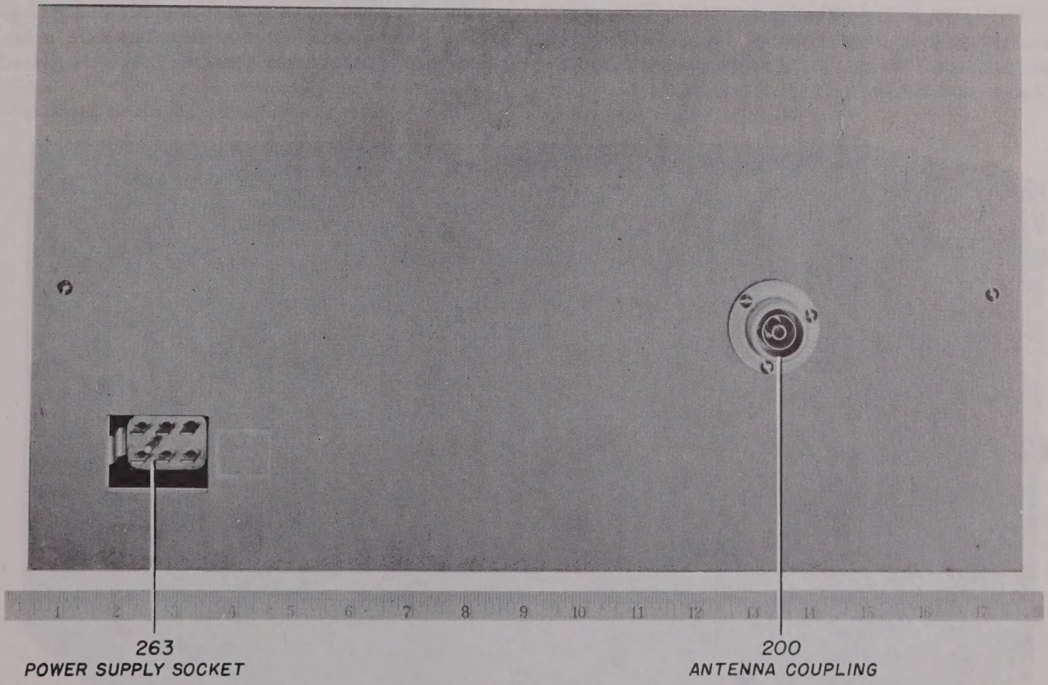


Figure 2 — Radio Receiver BC-639-A, Rear View, Dust Cover In Place

PE-100-A are used, the receiver is connected directly to a switch panel so you can switch to either power supply. In installations where only Rectifier RA-42-A (or Rectifier RA-42-B) is used, the receiver is connected directly to the power supply. If only the Dynamotor Unit PE-100-A is used, a separate single-pole, single-throw switch, is located externally to both the receiver and to Dynamotor Unit PE-100-A. It turns the dynamotor unit on and off.

5. TABLE MOUNTED IN CASE CS-134, NAVY ADAPTATION.

There are two models of Radio Receiver BC-639-A. One of these (Table Mounted, Navy Adaptation) is used only by the U. S. Navy while the other is supplied to the U. S. Army. These receivers are the same as the rack mounted Radio Receiver BC-639-A except for the following differences:

a. Radio Receiver BC-639-A (Table Mounted, Navy Adaptation) is mounted in Case CS-134 supported on four Lord shockmounts. This case replaces the dust cover used in the rack mounted radio receiver. The mounting screw passes through a washer and sleeve in the shockmount.

b. Case CS-134 is equipped with eight sets of contact springs. Four sets at the bottom front of the case and four sets at the top front of the case. These contact springs are used to make electrical connections between the front edge of the case and the front panel of the receiver thus making the shielding of the receiver complete.

c. The receiver is held in the case by six knurled thumbscrews which are located three on each side of the case. These screws are not removable; they are held in slots in the case by "C" washers.

d. The flange supporting the outside antenna coupling and the hole in the case through which the coupling fits, have been enlarged so that the outside antenna coupling does not need to be removed from the chassis when removing the receiver from the case.

(1) The model supplied to the U. S. Army uses three screws in the case around the outside antenna coupling to make a firm contact.

(2) The model supplied to the U. S. Navy uses no screws in the case around the outside antenna coupling but has four sets of four grounding springs around the outside antenna coupling hole inside the case for good contact when the receiver is placed in the case.

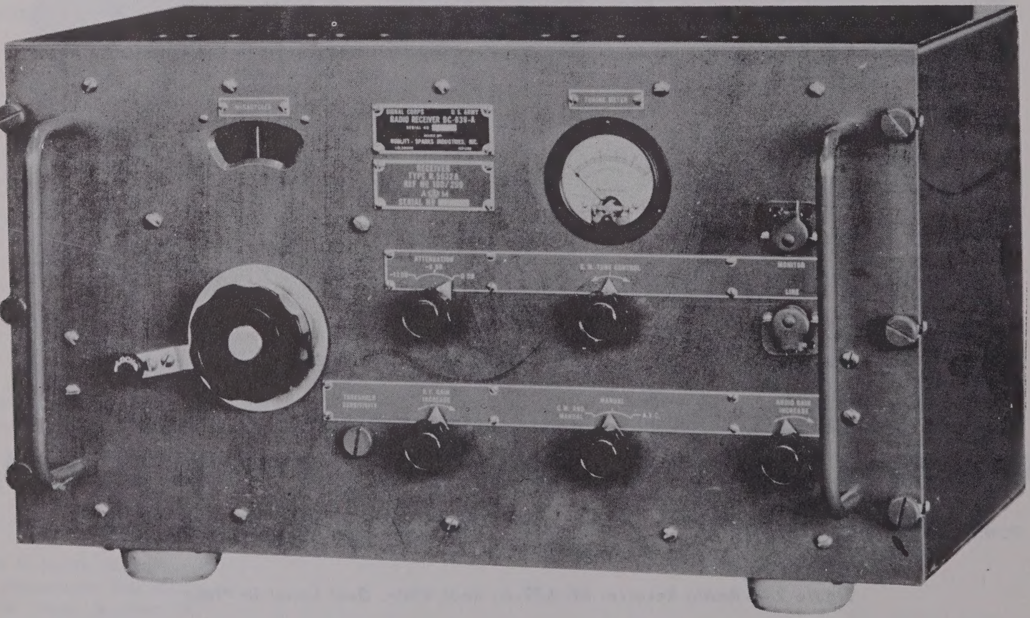


Figure 3 — Radio Receiver BC-639-A, (Navy Adaptation) Mounted in Case CS-134

SECTION II
INSTALLATION AND ADJUSTMENT

6. INSTALLATION.

a. INSTALLATION STANDARD RACK MOUNTING.—Grasp Radio Receiver BC-639-A by the handles mounted on the front panel (fig. 1) and slide it into its standard rack mounting from the front. The receiver is held in the rack by six #10-32 fillister-head screws, (with a lock washer and flat washer located under the head of each screw). Be sure that the flat washer is placed next to the panel. All outside connections to the receiver are made to the antenna socket 200 and to the power plug socket 263 at the rear of the chassis. When the unit is fastened firmly to the rack put the Jones plug, used for outside power and output connections, into the six-contact socket 263 provided for it in the rear of the chassis. (The six-contact socket is shown in figure 4.)

The receiver is connected to the dipole antenna through a 70-ohm coaxial antenna line. (20-100-ohms will give satisfactory results.) The coaxial cable used is complete with fittings for ease of assembly. It only needs to be plugged into the antenna socket 200 and locked in place with the lock nut on the end of the cable. (*See figure 2 for position of antenna socket 200 and socket 263.*)

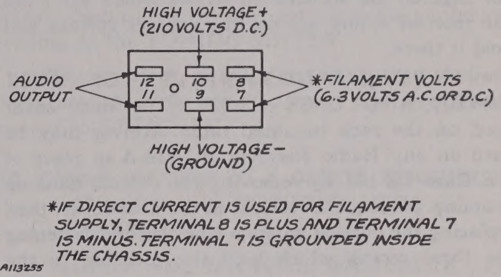

HIGH VOLTAGE +
(210 VOLTS D.C.)
AUDIO
OUTPUT
12
11
10
9
8
7
*FILAMENT VOLTS
(6.3 VOLTS A.C. OR D.C.)
HIGH VOLTAGE −
(GROUND)
*IF DIRECT CURRENT IS USED FOR FILAMENT SUPPLY, TERMINAL 8 IS PLUS AND TERMINAL 7 IS MINUS. TERMINAL 7 IS GROUNDED INSIDE THE CHASSIS.
A113255

Figure 4 — Radio Receiver BC-639-A, Socket Connections

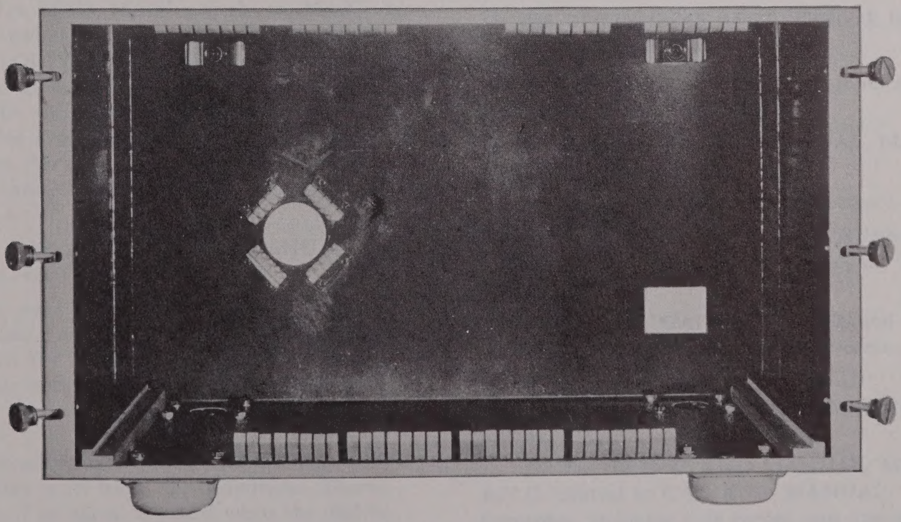


Figure 5 — Case CS-134

b. INSTALLATION IN CASE CS-134.

(1) Grasp the handles located on the front panel.

(2) Slide the unit into the case from the front. The brackets on the bottom of the unit fit into a grooved wooden track.

(3) Slide the unit into the case as far as it will go. Tighten the six knurled screws which will push the receiver firmly against the contact springs and hold it there.

c. INTERCHANGEABILITY OF DUST COVER AND CASE CS-134.—The dust cover used on the rack mounted radio receiver may be used on any Radio Receiver BC-639-A in place of the Case CS-134 by removing the outside antenna coupling, placing the receiver in the dust cover, then replacing the outside antenna coupling and fastening the three screws which hold the coupling to the flange.

7. PREPARATION FOR USE.

The Radio Receiver BC-639-A comes equipped with tubes mounted in the set. Everything should be complete and the receiver ready for operation. Prepare Radio Receiver BC-639-A for use as follows:

a. Insert the power plug in the rear of the receiver.

b. Connect the antenna plug to the antenna socket at the rear of the unit.

c. Check the power input voltage and frequency to the power supply. This should be 90 to 140 volts or 200 to 250 volts, 60 cycles, alternating current for Rectifier RA-42-A (or Rectifier RA-42-B), or 6-volts direct current for Dynamotor Unit PE-100-A.

d. Turn on the power on Rectifier RA-42-A (or Rectifier RA-42-B) by use of the **POWER ON** switch on the rectifier panel, or if the Dynamotor Unit PE-100-A is used, place switch at **BATTERY** on Switch Panel PN-6-A.

e. If Rectifier RA-42-A is used, wait approximately 30 seconds; the voltmeter on the rectifier panel should then indicate about 60 MA.

f. The receiver is now ready for operation.

SECTION III
OPERATION

8. GENERAL.

a. When power is supplied, dial lamp on the receiver should light.

b. Set the ATTENUATION switch to 0 DB.

c. Set the R.F. GAIN INCREASE control and AUDIO GAIN INCREASE control to maximum. (Turn knobs clockwise, to the right all the way).

d. Plug earphones in MONITOR jack on front panel of receiver.

e. With normal voltage applied and C.W. AND MANUAL, MANUAL, A.V.C. switch set at MANUAL, set the THRESHOLD SENSITIVITY for about 5 ma.

9. TUNING RECEIVER TO A DESIRED FREQUENCY WITH FREQUENCY METER BC-638-A.

a. If Frequency Meter BC-638-A is available, insert proper crystal (whose frequency is desired frequency ÷ 18) in Frequency Meter BC-638-A, set CRYSTAL SELECTOR switch to position corresponding to the number of the crystal selected, turn MIN.-MED.-MAX. switch to MAX., turn ON-OFF switch to ON, set STAND BY-OPERATE switch to OPERATE and turn tuning knob so that the green glow of the "magic-eye" indicator tube makes the smallest angle. The dial reading in megacycles should be about 18 times the crystal frequency. *For complete details see Handbook of Maintenance Instructions for Frequency Meter BC-638-A.*

b. Set C.W. AND MANUAL, MANUAL, A.V.C. switch on receiver to A.V.C.

c. The main tuning dial is directly calibrated in megacycles. Turn the tuning dial so that the dial reading is the same as the frequency desired. A 1000 cycle note should be heard in the earphones.

CAUTION

It occasionally happens that the dial calibration is off from 1 to 3 divisions. Therefore, if no signal is heard when the dial is set to the desired frequency, rotate the dial slowly about 3 or 4 divisions to each side of the desired dial reading and listen for the signal to come in.

d. Adjust the main tuning dial for the loudest signal which will be the same setting as the minimum reading on the TUNING METER.

e. The receiver is now tuned to the desired frequency. *Now be sure to turn the frequency meter to STAND BY.*

10. TUNING RECEIVER TO A DESIRED FREQUENCY WITHOUT USING FREQUENCY METER BC-638-A.

a. Set C.W. AND MANUAL, MANUAL, A.V.C. control to A.V.C.

b. The main tuning dial is directly calibrated in megacycles so that the dial can be tuned directly to the frequency desired. If a transmission on a known frequency is to be picked up, turn the tuning dial until it reads about the same as the transmission frequency. If the signal is strong enough to be heard turn the dial for the loudest signal which will be the same setting as for the minimum reading on the TUNING METER.

11. USE OF CONTROLS AFTER RECEIVER IS TUNED TO DESIRED FREQUENCY.

a. For amplitude-modulated communication, set the receiver controls as follows:

(1) Set the C.W. AND MANUAL, MANUAL, A.V.C. control at A.V.C.

(2) Set the ATTENUATION control at 0 DB.

(3) Set the AUDIO GAIN INCREASE control at a comfortable level after the signal has been tuned in.

(4) The R.F. GAIN INCREASE and the C.W. TONE CONTROL are not used for communication reception.

b. For c-w signals, set the receiver controls as follows:

(1) Set the C.W. AND MANUAL, MANUAL, A.V.C. control at C.W. AND MANUAL. The beat frequency oscillator now comes into operation.

(2) Set the AUDIO GAIN INCREASE control at maximum (fully clockwise).

(3) Set the ATTENUATION control at 0 DB.

(4) The receiver should be tuned to zero beat (no whistle), when the C.W. TONE CONTROL pointer is at the index line. If the receiver is not then tuned to zero beat, adjust the main tuning dial for zero beat with the C.W. TONE CONTROL pointer at the index line.

(5) Adjust the C.W. TONE CONTROL for the most pleasing tone.

(6) Set the R.F. GAIN INCREASE control to the point where the signal is just comfortably audible. *To avoid overloading and to give a sharp minimum, it is very important to work at a low signal level by reducing the setting of the R.F. GAIN INCREASE control as much as possible.*

(7) The C.W. TONE CONTROL may need readjustment to keep the note audible.

c. For direction finding on a modulated signal, set the receiver controls as follows:

(1) Set the C.W. AND MANUAL, MANUAL, A.V.C. control at MANUAL.

(2) Set the AUDIO GAIN INCREASE control at maximum (fully clockwise).

(3) Set the ATTENUATION control at 0 DB.

(4) Set the R.F. GAIN INCREASE control at the point where the signal is just comfortably audible. To avoid overloading and to give a sharp minimum, *it is very important to work at a low signal level by reducing the setting of the R.F. GAIN INCREASE control as much as possible.*

12. USE OF THE TUNING METER

In addition to the above use for tuning the receiver, the TUNING METER indicates the strength of the incoming signal. A strong signal produces a large reduction while a weak signal produces a small reduction in reading. The approximate values are as follows:

Signal Strength	*Ma On TUNING METER*
zero microvolts	5.0 MA
10 microvolts	5.0 MA
100 microvolts	4.8 MA
1000 microvolts	3.2 MA
10,000 microvolts	2.0 MA
100,000 microvolts	1.2 MA

REMEMBER THESE POINTS

1. Make sure that the antenna plug is firmly seated in the antenna socket at the rear of the receiver.
2. If available always use the Frequency Meter BC-638-A for tuning the receiver to the desired frequency.
3. Make sure that the Frequency Meter BC-638-A has been switched to STAND-BY after it has been used to tune the receiver.
4. Since the calibration of the receiver may drift slightly for about the first twenty minutes, the receiver should be allowed to warm up at least twenty minutes before the final tuning is begun.
5. While monitoring, keep the receiver GAIN controls turned up. This way faint signals will not escape your attention.

SECTION IV

MECHANICAL AND ELECTRICAL CHARACTERISTICS

13. GENERAL.

Radio Receiver BC-639-A consists of:

1. A radio frequency amplifier stage
2. An oscillator
3. An oscillator doubler
4. A mixer stage
5. Three intermediate frequency amplifier stages
6. A second detector
7. Automatic volume control
8. First audio stage
9. An audio output stage
10. *A beat frequency oscillator can be switched into the second detector when desired.*

The schematic diagram of Radio Receiver BC-639-A is shown in fig. 22. A block diagram of Radio Receiver BC-639-A is shown in fig. 6.

The antenna socket on the receiver unit is coupled to the grid coil of the radio frequency amplifier stage by a short piece of coaxial transmission line. The radio frequency stage uses a pentode Tube VT-203 (9003). From the radio frequency stage the signal frequency is fed into a mixer stage which uses the same type tube. The plate circuit of the mixer is tuned to the intermediate frequency of 12 megacycles. There are three intermediate frequency stages using remote cut-off pentode Tubes VT-211 (6SG7). From the third intermediate frequency stage the intermediate frequency of 12 megacycles is fed into diode plate #1 of the second detector and first audio amplifier stage, which uses a single Tube VT-103 (6SQ7). The detected signal is fed through the ATTENUATION switch into the grid of the second audio Tube VT-152 (6K6-GT G), which is the audio output stage.

The output frequency of the doubler Tube VT-203 (9003) differs from the signal frequency by

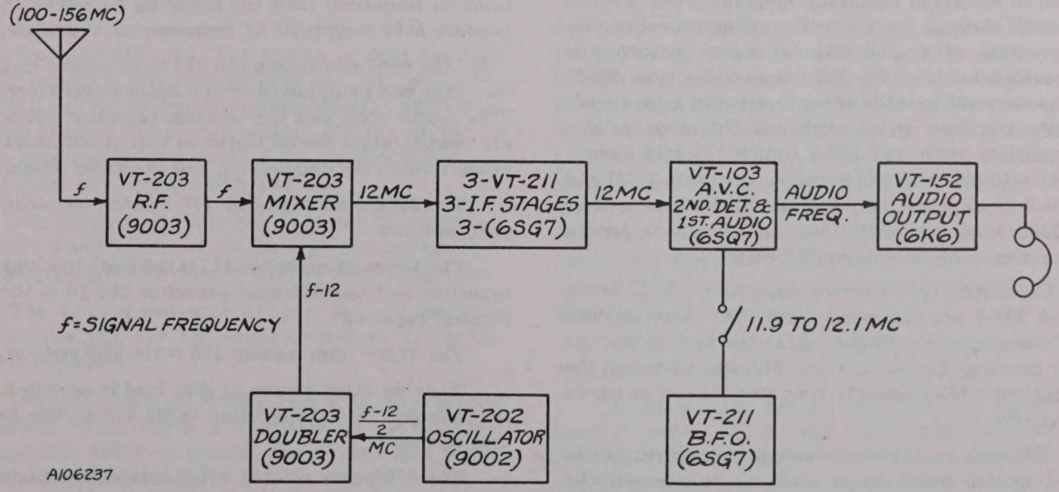

(100-156 MC)
f
VT-203
R.F.
(9003)
f
VT-203
MIXER
(9003)
12MC
3-VT-211
3-I.F. STAGES
3-(6SG7)
12MC
VT-103
A.V.C.
2ND. DET. &
1ST. AUDIO
(6SQ7)
AUDIO
FREQ.
VT-152
AUDIO
OUTPUT
(6K6)
f-12
f=SIGNAL FREQUENCY
11.9 TO 12.1 MC
VT-203
DOUBLER
(9003)
f-12/2 MC
VT-202
OSCILLATOR
(9002)
VT-211
B.F.O.
(6SG7)
A106237

Figure 6 — Radio Receiver BC-639-A, Block Diagram

12 megacycles and the high frequency oscillator Tube VT-202 (9002), is tuned to half the doubler output frequency. Thus while the signal frequency circuits tune from 100 to 156 megacycles, the doubler tunes from 88 to 144 megacycles, and the high frequency oscillator tunes from 44 to 72 megacycles. The local signal from the doubler and high frequency oscillator is introduced into the mixer by inductive coupling between the mixer grid coil and the doubler plate coil.

The output of the beat frequency oscillator, which uses a remote cut-off Tube VT-211 (6SG7), is injected into diode plate #1 of the second detector which is used for demodulation. The beat frequency oscillator is automatically turned on when the C.W. AND MANUAL, MANUAL, A.V.C. switch is set at C.W. AND MANUAL.

The filaments of all of the tubes in the receiver unit operate from a 6 volt supply.

The plate voltage supply should be 210 volts, D. C.

14. CIRCUITS OF THE RADIO FREQUENCY AMPLIFIER.

When a VHF signal is introduced into the antenna coil 201 it causes a radio frequency voltage to appear across the upper portion of the coil due to autotransformer action. This voltage is applied to the control grid of the radio frequency amplifier Tube VT-203 (9003), through the 15-mmf coupling capacitor 203. One stage of amplification at signal frequency is provided using a VT-203 (commercial type 9003) super-control pentode tube, in a tuned-grid, tuned-plate amplifier circuit, with coil 201, and variable capacitors 202A and 204-1 tuning the grid circuit, and with coil 212, and variable capacitors 202B and 204-2 tuning the plate circuit. Variable capacitors 202A, 202B and 202C form a three-gang tuning capacitor with an ungrounded rotor.

Concentric type trimmer capacitors 204-1, 204-2, and 204-3 are connected across the three sections of this capacitor. Alignment at the factory is done by bending the coils 201 and 212, and trimming the capacitors 204-1 and 204-2, so that the circuit tracks properly.

Extreme care must be taken in examining the set not to bend these coils, or to disturb the setting of these capacitors.

The 15-mmf capacitor 203 isolates the d-c grid voltage on the Tube VT-203 from a metallic ground through the grid coil 201. The 680-mmf capacitor 205-1 and 100,000-ohm resistor 206 and 560,000-ohm resistor 207 act as a filter network for the a.v.c. voltage applied to the grid. Minimum grid bias for the radio frequency tube is provided by a 330-ohm cathode resistor 208. The cathode is grounded for radio frequency through a 680-mmf by-pass capacitor 205-2. The 680-mmf capacitor 205-4 is the plate to cathode by-pass. The suppressor grid of this tube is tied directly to the cathode. The screen grid is bypassed to ground by 680-mmf capacitor 205-5 and supplied with voltage through the 39,000-ohm dropping resistor 210. The 120,000-ohm resistor 209 acts as a bleeder resistor to stabilize the screen voltage. The plate voltage is supplied through the 1000-ohm resistor 211-1. The 680-mmf capacitor 205-6, is the plate-to-ground r-f by-pass capacitor. Due to the inductive coupling of the radio frequency amplifier plate and mixer grid coils 212 and 213 the amplified signal is introduced into the mixer grid circuit.

15. CIRCUIT OF HIGH FREQUENCY OSCILLATOR.

a. The high-frequency oscillator tube is a VT-202 (9002) triode, in a modified Hartley circuit. A buffer-doubler stage is used, so the oscillator frequency is not as high, and the r-f output voltage is not as great as it would be if the oscillator were of the conventional type. This oscillator-doubler arrangement is designed to track 12 megacycles lower in frequency than the incoming r-f signal, to produce a 12 megacycle i-f frequency at the mixer.

b. The oscillator tuning coil 223 has a copper slug core that can be adjusted with a small screwdriver. This copper slug, and the trimmer capacitor 204-5, are used to align the oscillator so that it will track properly with the doubler, r-f, and the mixer stages.

The 1000-mmf capacitor 276-1 is the oscillator grid capacitor.

The 150-mmf capacitor 225 is the plate blocking capacitor and the 680-mmf capacitor 205-14 is the filament capacitor.

The 47,000-ohm resistor 226 is the grid resistor.

Since no other source of grid bias is provided, the only grid bias voltage that exists will be due to grid current.

The 4700-ohm resistor 219-2 acts as the plate dropping resistor.

This oscillator is capacity coupled through the 27-mmf capacitor 224, to the grid of the doubler stage.

16. CIRCUIT OF THE DOUBLER STAGE.

The doubler stage uses a VT-203 (9003) super-control pentode tube. The oscillator feeds directly into the untuned grid of this stage through the 27-mmf capacitor 224. The 27,000-ohm resistor 222 is the grid resistor. The plate circuit is tuned to twice the frequency of the oscillator by means of coil 214 (which is one turn of silvered copper wire) and the tuning capacitor 218A together with its trimmer capacitor 204-4.

The coupling of coil 214 to coils 212 and 213 is not very critical, so small changes in its position can be tolerated. Plate potential is applied to the tube through the 4700-ohm resistor 219-1, with the 680-mmf capacitor 205-10 as its by-pass capacitor. Screen potential is applied to the tube through the 56,000-ohm resistor 220 with the 680-mmf capacitor 205-11 as its by-pass capacitor.

Cathode bias is provided through the 560-ohm cathode resistor 221, with the 680-mmf capacitor 205-12 as the cathode by-pass capacitor.

The filament is by-passed by 680-mmf capacitor 205-13. Thus while the signal frequency circuits tune from 100-156 megacycles, the doubler tunes from 88-144 megacycles, and the high frequency oscillator tunes from 44-72 megacycles.

17. CIRCUIT OF THE MIXER STAGE.

The mixer stage uses a VT-203 (9003) super-control pentode tube. The mixing is done through the inductive coupling of coils 212, 213 and 214. The coupling between the radio frequency and mixer coils 212 and 213 is very critical, and can be varied by compressing or spreading the turns of either the r-f plate coil or the mixer grid coil.

The grid circuit, coil 213, is tuned by capacitor 202C, which is part of the three gang capacitor that tunes the grid and plate circuits of the r-f stage also.

The 47-mmf capacitor 215-1 is the grid coupling capacitor and the 1.8 megohms resistor 216 is the grid resistor.

Cathode bias is provided by the 1000-ohm cathode resistor 211-2, which is by-passed by the 680-mmf capacitor 205-7 to ground. A.v.c. grid bias is not furnished to this stage.

The screen grid voltage is supplied through the 270,000-ohm resistor 217 and is by-passed to ground by 680-mmf capacitor 205-9. Plate voltage is supplied through the 1000-ohm resistor 235-1 and the primary of the first intermediate frequency amplifier transformer 231.

The .0068 mfd capacitors 230-1 and 230-2 by-pass the r-f from the plate circuit to ground and thereby keep the radio frequencies out of the power supply.

The three tuned circuits preceding the mixer tube, and tuned to the signal frequency increase the selectivity and thus the image rejection. Also, the high intermediate frequency of 12 megacycles results in a 24-megacycle frequency separation between the desired signal and the image. This places the image relatively far away from the peak of the resonance curve of the signal-frequency tuned circuits.

For instance, if the desired signal has a frequency of 130 megacycles, the high frequency oscillator will provide a 118-megacycle local signal, resulting in the 12-megacycle intermediate frequency. The image frequency is then 106-megacycles. However, since the three tuned circuits preceding the mixer grid are selective and tuned to 130-megacycles, the response of these tuned circuits to the image frequency of 106-megacycles will be very small.

18. CIRCUIT OF THE INTERMEDIATE FREQUENCY AMPLIFIER STAGES.

a. There are three intermediate frequency amplifier stages (four intermediate frequency transformers) used, each using a Tube VT-211 (6SG7). The intermediate frequency amplifier operates at a frequency of 12 megacycles, with a band width of 140,000 cycles at a point 6db down. The i-f transformers are semi-tuned by special high frequency 60-mmf fixed capacitors 228-1, 2, 3, 4, 5, 6, 7, and 8. These capacitors are paralleled by small 15-mmf capacitors 227-1, 2, 3, 4, 5, 6, 7, and 8, which are temperature compensating capacitors that act to keep the i-f transformers tuned to the proper i-f frequency when the set is subjected to temperature variations. The final tuning of the i-f transformers is done by adjusting the special powdered iron-cores in the coils themselves.

b. Grid bias voltage for the i-f stages is obtained from three sources.

(1) Each stage has its own 220-ohm cathode resistor 237-1, 237-2, and 237-3 and associated .0068-mfd cathode capacitor 230-4, 230-8, and 230-12 which develops a certain fixed cathode voltage on each tube, depending on the cathode circuit of each tube.

(2) Grid bias voltage is developed across the 300-ohm THRESHOLD SENSITIVITY control 241

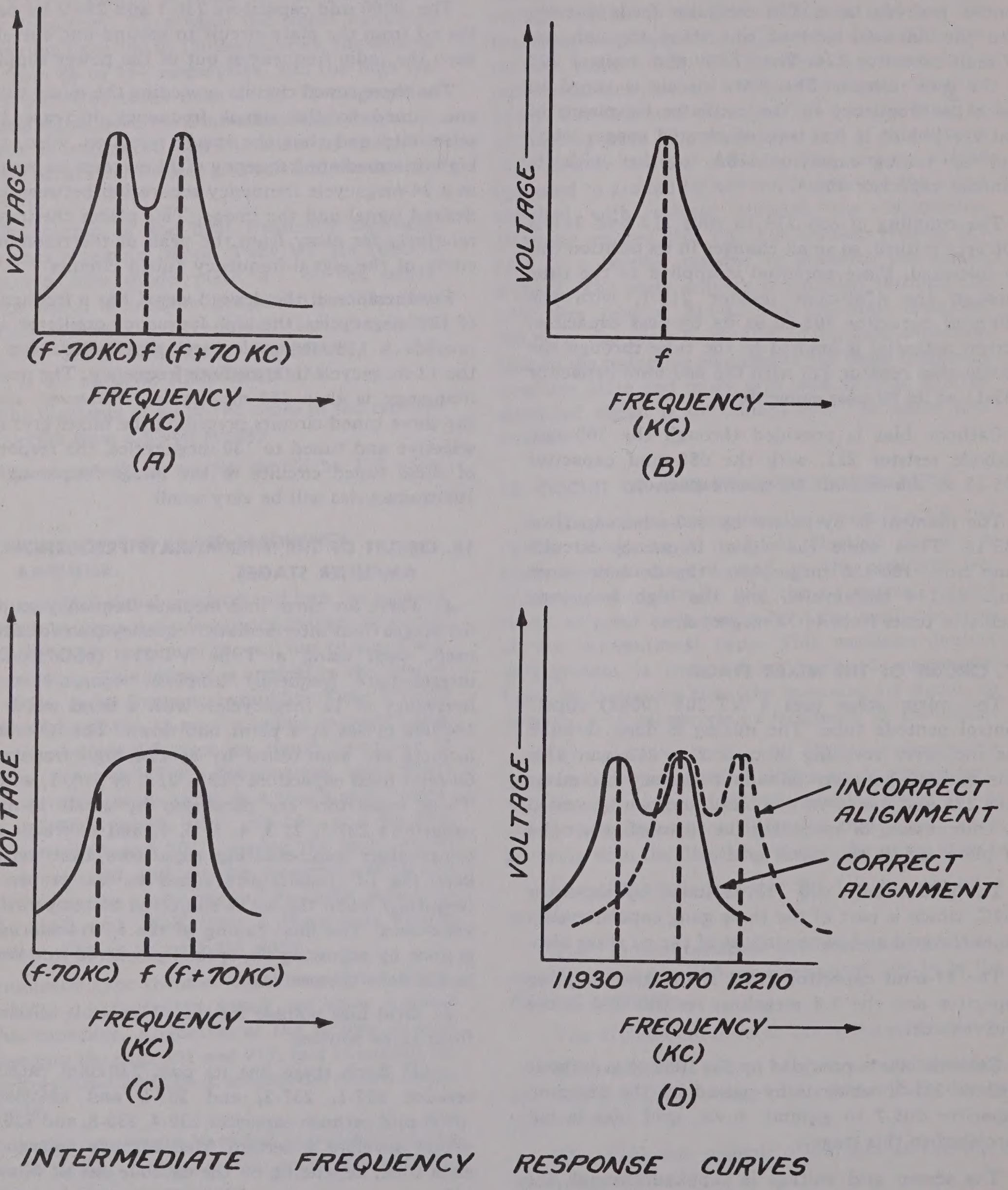


Figure 7 — Intermediate Frequency Response Curves

when the C.W. AND MANUAL, MANUAL, A.V.C. switch is on A.V.C. The grid bias voltage appears across the THRESHOLD SENSITIVITY control 241 and the R.F. GAIN INCREASE control 242 when this switch is at C.W. MANUAL or MANUAL. The setting of the THRESHOLD SENSITIVITY control determines the overall gain of the i-f amplifier. This THRESHOLD SENSITIVITY control is set at the factory and should very seldom need adjusting, except to compensate for sensitivity loss due to tube life, since in all positions but the A.V.C. position the 3000-ohm R.F. GAIN INCREASE control 242 will also vary the overall gain of the i-f stages as well as the first r-f stage. THRESHOLD SENSITIVITY and R.F. GAIN INCREASE controls 241 and 242 are by-passed by 1.0 mfd capacitor (239-1).

(3) The third source of grid bias voltage is an a.v.c. voltage, which is applied to the first r-f stage through the 100,000-ohm resistor 206 and the 560,000-ohm resistor 207 and also the first and second i-f stages through 100,000-ohm resistors 236-1 and 236-2 respectively. The 680-mmf capacitor 205-1, and the two .0068-mfd capacitors 230-3 and 230-7 are the respective grid by-pass capacitors for the above resistors. A.V.C. voltage is developed in the second detector stage, and will be discussed under the next heading. The screen grid voltage is applied through 47,000-ohm screen dropping resistors 238-1, 238-2 and 238-3 respectively with .0068-mfd capacitors 230-5, and 230-9, and 230-14 respectively, acting as screen grid by-pass capacitors.

Plate voltage is applied to each stage through the 1000-ohm plate resistors 235-2, 235-3 and 235-4 respectively, the plate voltage for each stage passing through the primary winding of the following stage. The .0068-mfd capacitors 230-6, 230-10 and 230-15 are plate r-f return by-pass capacitors. Only the filament of the third i-f stage is by-passed by the .0068-mfd capacitor 230-13.

c. The plate current of the first intermediate frequency amplifier is measured by 0-10 milliampere TUNING METER 240. The plate current of this tube varies inversely with the a.v.c. voltage applied to the grid of the first intermediate frequency tube through the 100,000-ohm resistor 236-1 and the secondary coil of the first intermediate frequency transformer 231. Since the a.v.c. voltage varies with the signal strength, this meter will give an indication of the strength of the incoming signal. *The greater the strength of the input signal, the greater will be the a.v.c. voltage developed and thus the greater will be the bias applied to the grid of the first i-f tube.* This will result in a decrease in plate current of the first i-f tube and hence a decrease in the meter reading. Therefore, the lower the meter reading the greater the input signal strength.

d. The first two intermediate frequency transformers are over-coupled, giving a double-humped frequency-response curve, with peaks occuring 70 kilocycles each side of 12 megacycles. The combination of the four transformers provides a 12-megacycle, band-pass response curve 140-kilocycles wide. This characteristic gives good selectivity while providing a band-pass sufficiently wide that the receiver will remain in tune despite small variations that may occur in signal frequency or in the receiver high-frequency oscillator. Figure 7a shows the double-peaked response curve for the first two i-f transformers and figure 7b shows the sharp response curve for the last two i-f transformers. The overall resulting response curve figure 7c will be a comparatively flat band-pass, about 140-kilocycles broad.

In the alignment instructions, after the 4th and 3rd i-f transformers are peaked at 12 megacycles, you are instructed to peak the 2nd and 1st i-f transformers at the frequency of 12070 kilocycles which corresponds to the frequency of the right hand peak present in the transformer's response curve. After alignment of both the 2nd and 1st i-f stages at the 12070 kilocycles setting, the same procedure is carried out for 11930 kilocycles.

Reference to figure 7d will show why these first two stages must be aligned separately for 12070 kilocycles and 11930 kilocycles. It is possible that when adjusting the 1st two i-f transformers to peak at 12070 kilocycles, the peak you get will be at 12070 kilocycles but will be the left-hand peak, with the right-hand peak 140 kilocycles away at 12210 kilocycles. To check that the peak at 12070 kilocycles is definitely the right peak, you feed a 11930 kilocycles signal in, and you adjust the iron core for maximum response. If the setting of the iron-core is about the same for 11930 kilocycles as for 12070 kilocycles, you are then sure that the response of the 1st and 2nd i-f transformers is the desired response, peaking plus and minus 70 kilocycles on each side of 12,000 kilocycles.

19. CIRCUIT OF THE SECOND DETECTOR, FIRST AUDIO, A.V.C. STAGE.

a. The second detector, first audio, a.v.c. stage uses a dual diode-triode VT-103 (commercial type 6SQ7) tube. One diode acts as a half-wave rectifier type detector, and the other diode gives the a.v.c. voltage, while the triode acts as the first-audio stage. The 47-mmf capacitor 215-2 is connected directly between the diode plates of the tube. So as far as r-f voltage (or i-f voltage) is concerned the diode plates are tied together electrically, but as far as the detected audio frequency, or detected a.v.c. voltage is concerned the diode plates are separated electrically. The r-f (i-f) voltage is applied to the diodes through the diode that is directly connected to the secondary of the 4th i-f transformer.

From detector theory it can be shown that several harmonic frequencies, plus pulsating d-c (audio-frequency), plus a d-c component are produced by diode detection. These components will appear in the circuit of each diode plate. In the circuit of the diode plate connected directly to the secondary of the 4th i-f coil, the 47-mmf capacitor 215-2, the 1.8-mmf capacitor 246 and the 330-mmf capacitor 245-1 are too small to pass anything but r-f, but capacitor 245-1 will ground most of the r-f at this point, leaving the rectified (modulating) frequency, plus a d-c voltage that will appear across the 100,000-ohm resistors 236-4 and 236-5. The 220-mmf capacitor 247 across the 100,000-ohm resistor 236-5 further reduces the r-f voltage across resistor 236-5. The audio frequency developed across resistor 236-5 goes through the .0068-mfd blocking capacitor 230-17 and appears across the 1-megohm potentiometer 251, which acts as audio volume control and grid resistor for the first audio stage.

b. The second diode plate is used to produce a.v.c. voltage. Most of the rectified voltage from this plate appears across 1-megohm resistor 244-1. To be useful a.v.c. voltage has to be d-c voltage. Therefore 1-megohm resistor 244-2 and .0068 mfd capacitor 230-16 act as a filter to remove practically all components of the detector voltage but the d-c component. This voltage is fed to the first r-f stage through the 100,000-ohm resistor 206 and 560,000-ohm grid resistor 207, by-passed by the 680-mmf capacitor 205-1; to the first i-f stage through the 100,000-ohm resistor 236-1, by-passed by the .0068 mfd capacitor 230-3; and to the second i-f stage through the 100,000-ohm resistor 236-2, by-passed by the .0068-mfd capacitor 230-7. These resistor-capacitor combinations are very effective as filters, since the grid circuit draws very little current. They remove practically all but the d-c from the a.v.c. bus and very effectively decouple the stages connected to the a.v.c. bus.

c. The triode unit of this stage functions as the first audio stage. As we have seen above the audio signal is fed through from the detector to the audio volume control, 1-megohm resistor 251, which functions as the grid resistor. The grid bias voltage for this stage is developed across 18,000-ohm resistor 249 and 2200-ohm resistor 250, by-passed by 0.1-mfd capacitor 248 in the cathode circuit. The delay action of the a.v.c. circuit is determined by 18,000-ohm resistor 249. The plate load consists of 68,000-ohm resistor 252, and two 33,000-ohm resistors 253-1 and 253-2. These resistors are connected to three position switch 254, forming an audio attenuator that is used to regulate the audio output level. The 330-mmf capacitor 245-2 in the plate circuit of the first audio stage is used to ground any r-f voltage that might have leaked through the second detector circuit.

20. CIRCUIT OF THE C-W OSCILLATOR STAGE.

The c-w oscillator uses a VT-211 (6SG7) pentode tube. The circuit is a little unusual in that the grid circuit is tuned to one half the i-f frequency, or 6 megacycles, while the plate circuit is tuned to the first harmonic of the oscillator frequency or 12 megacycles. This is done to prevent the c-w oscillator from "locking in" with the i-f frequency, and thus failing to function as a c-w oscillator. The circuit is a type of electron coupled oscillator.

The grid circuit is tuned by coil 269 and 390-mmf capacitor 271 and variable capacitor 270 (C.W. TONE CONTROL).

The 1000-mmf capacitor 276-2 is the oscillator grid blocking capacitor. The 47,000-ohm resistor 238-4 is the grid resistor. The .0068-mfd capacitor 230-20 is the plate r-f bypass capacitor. The screen-grid of the tube acts as the plate for the oscillating circuit. High voltage is supplied to the screen grid through 47,000-ohm resistor 268 and a tap on coil 269. The plate circuit of the tube is connected to the oscillator through the electron stream in the tube itself, and is tuned to 12 megacycles by coil 266 and by 100-mmf capacitor 265.

The final tuning of the plate circuit is done by the adjustment of an iron-core in the coil 266. The output of the c-w oscillator is fed to the diode detector plate that is tied to the secondary of the last i-f transformer through 1.8-mmf capacitor 246 and 4.7-mmf capacitor 267. These two capacitors are used in series to reduce the load on the oscillator and to prevent too much interaction between circuits. The frequency of the beat frequency oscillator is variable slightly above and below 12 megacycles and since the intermediate frequency feeding the second detector is 12 megacycles, this will produce an audible beat (tone) in the output. The frequency of the beat note will be the difference between the beat frequency oscillator frequency and the intermediate frequency and may be varied by adjusting the C.W. TONE CONTROL knob on the front panel.

21. CIRCUIT OF THE SECOND AUDIO STAGE.

The second audio stage uses a VT-152(6K6-GT/G) pentode tube. The circuit is that of the usual resistor-capacitor coupled pentode amplifier. Grid bias voltage is developed across 560-ohm cathode resistor 256, by-passed by 1.0 mfd capacitor 239-2. The grid bias on this tube is purposely made a little high to reduce the gain and power output of this stage, in order to prevent the plate from drawing more than 60-ma. current. The 330,000-ohm resistor 255 is the grid return resistor, and .0068-mfd capacitor 230-18 is the coupling capacitor from the plate circuit of the first audio stage. Screen grid voltage is supplied directly from the high voltage supply for the receiver.

The plate of the second audio stage works into the primary of transformer 258, which is used to match the impedance of the plate circuit to the impedance of the line. This transformer is designed to work into a 600-ohm line, but it will work satisfactorily into an impedance of from 200 to 10,000 ohms. The .0068-mfd capacitor 257 is used to peak the response of transformer 258 to 1000 cps., which is the most useful audio frequency of this set. The transformer 258 has a balanced output and an electrostatic shield between its windings to insure that the receiver output circuit is suitable for the direct connection to the telephone line circuit. The 4700-ohm resistor 261 is used to ground the center of the transformer, since neither side of the line is grounded.

The secondary of the transformer 258 is connected to two jacks 262-1 and 262-2 and to line terminals Nos. 11 and 12. Jack 262-1 is the MONITOR jack while jack 262-2 is the LINE jack. Plugging into LINE jack 262-2 will open both leads to the line terminals Nos. 11 and 12, thus cutting off the line to the silence cabinets.

22. SHIELD CANS.

The following units are enclosed in separate shield cans: (fig. 16)

a. Four i-f transformers and their associated capacitors.

b. The output transformer.

c. The entire oscillator-doubler unit.

d. The primary coil tuning assembly of the c-w oscillator.

23. FUNCTION OF OPERATING CONTROLS.

a. MAIN TUNING CONTROL.—The main tuning control is a large knob that rotates a lighted dial marked, MEGACYCLES. The dial, calibrated to read directly in megacycles, is behind a window in the front panel and only a small part of it can be seen. This control drives the five tuning capacitors which are ganged three on one gang and two on one gang.

The three gang capacitor consists of the tuning capacitor for the grid of the radio frequency stage, the plate of the radio frequency stage and the grid of the mixer stage.

The two gang capacitor tunes the oscillator and doubler plate circuits. These two gangs are connected together by anti-backlash gears. The dial light 273 is located behind the front panel and at the left side of the scale.

b. THRESHOLD SENSITIVITY.—The THRESHOLD SENSITIVITY control is a 300-ohm linear rheostat. It is reached by first removing the slotted plug from the front panel which uncovers the screwdriver adjustment of the control. This control is adjusted to about 5-ma with the R.F. GAIN INCREASE control full ON, and is used to increase the gain of the receiver when it is low.

c. R.F. GAIN INCREASE.—The R.F. GAIN INCREASE control gives manual radio frequency gain control by means of a 3000-ohm rheostat in the cathode circuit of the first radio frequency tube. This control is grounded out when the C.W. AND MANUAL, MANUAL, A.V.C. switch is turned to A.V.C. When the receiver is being used for direction finding purposes the signal is kept at a comfortable level by means of the R.F. GAIN INCREASE in order to avoid overloading and get a sharp minimum.

d. C.W. AND MANUAL, MANUAL, A.V.C.—This switch has three positions marked **C.W. AND MANUAL, MANUAL, A.V.C.** It is used to select the position which determines whether the function of the receiver is to be communication or direction finding. When at **C.W. AND MANUAL** the beat frequency oscillator is supplied screen and plate voltages, giving an audio tone in the output when a signal is tuned in. In this position the A.V.C. is cut out, thus making the control of the receiver gain entirely manual. This setting is used in taking D/F bearings and for locating weak signals. In the **MANUAL** position the beat frequency oscillator is **OFF**, the A.V.C. is cut out and the control of the receiver gain is entirely manual, so that the D/F bearings can be taken on normal signals. When at **A.V.C.** the beat frequency oscillator is **OFF** and the automatic volume control functions normally, making this setting suitable for radio telephone communication. In this position fading is minimized and the output practically constant regardless of variations in carrier signal strength. The **R.F. GAIN INCREASE** control is out of the circuit and the volume is controlled by the **AUDIO GAIN INCREASE** control and the **ATTENUATION** control.

e. AUDIO GAIN INCREASE.—The **AUDIO GAIN INCREASE** control (251) consists of a 1-megohm potentiometer connected in the input circuit of the 1st audio portion of the second detector, and is adjusted to control the audio input to the audio amplifier stages.

f. **ATTENUATION.**—The **ATTENUATION** control is a three-position switch (—12 DB, —6 DB, 0 DB) which attenuates the audio level down to 12 db below normal by the connections to a resistance network in the output of the 1st audio amplifier stage. It determines the maximum audio output but is normally left at 0 DB.

g. **C.W. TONE CONTROL.**—The **C.W. TONE CONTROL** knob controls a variable capacitor 270 in the beat frequency oscillator circuit. This control changes the frequency of the oscillator slightly, resulting in a change in the pitch of the beat note.

h. **MONITOR JACK.**—The **MONITOR** jack is a bridging jack. By inserting a headphone plug into this jack you will place the headphones across the line with no interruption of the externally connected line.

i. **LINE JACK.**—The **LINE** jack is a lifting jack. By inserting a headphone plug into this jack, the phones will be connected to the output of the receiver but the external line will be automatically disconnected.

j. **TUNING METER.**—The **TUNING METER** is a DC milliammeter in the plate circuit of the first intermediate frequency stage which functions only when the **C.W. AND MANUAL, MANUAL, A.V.C.** control is at **A.V.C.** The meter indicates minimum current when the receiver is tuned to a signal as well as the relative signal strength of various carriers. A weak signal gives a small deflection and a strong signal a large deflection on the meter.

SECTION V

MAINTENANCE

24. GENERAL.

Before removing a component from Radio Receiver BC-639-A find out the cause of failure and the particular faulty component or circuit of the equipment. *LOOK FOR THE SIMPLE CAUSES OF TROUBLE FIRST.*

Many defects can and may develop in a complex piece of radio equipment. Remember that time can always be saved by finding out the *cause* of trouble and the sub-assembly or component that is to blame.

Study the complete schematic circuit diagram and check the various possible causes of failure. When you have detected the bad unit, beyond a reasonable doubt, remove and repair it or replace it with a good unit.

A suitable dummy antenna for testing Radio Receiver BC-639-A is electrically the same as a

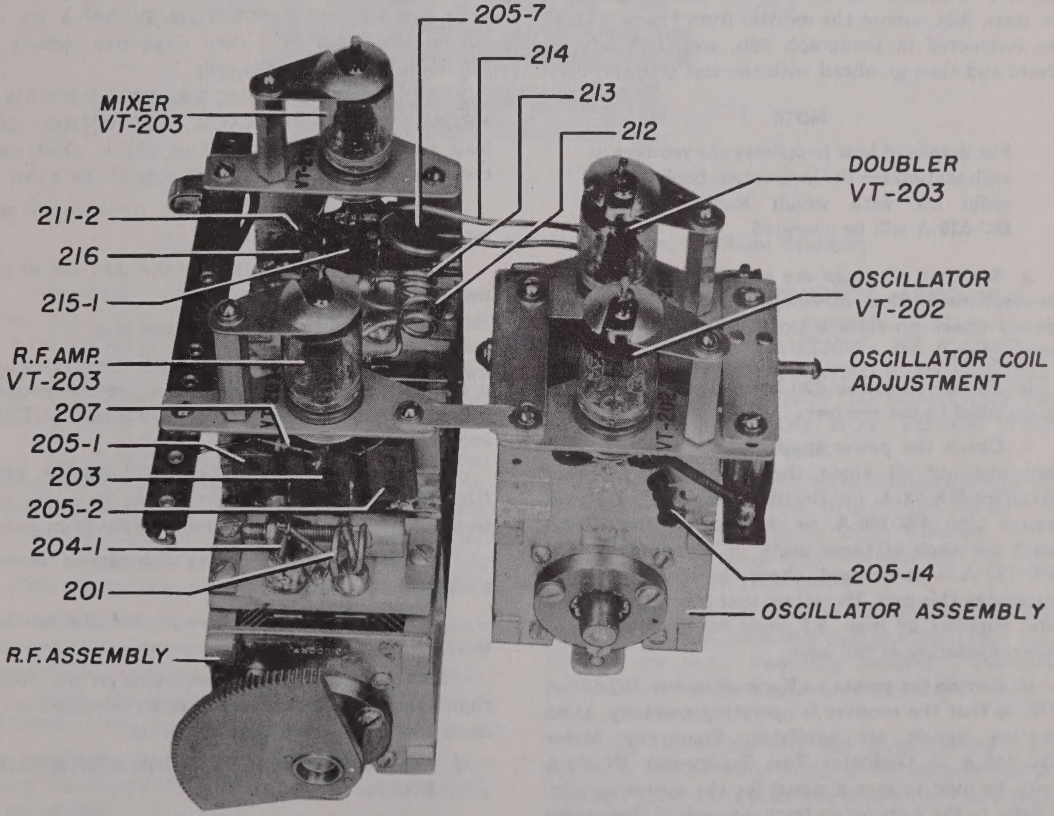

205-7
214
213
212
MIXER VT-203
211-2
216
215-1
R.F. AMP. VT-203
207
205-1
203
205-2
204-1
201
R.F. ASSEMBLY
DOUBLER VT-203
OSCILLATOR VT-202
OSCILLATOR COIL ADJUSTMENT
205-14
OSCILLATOR ASSEMBLY

Figure 8 — Radio Receiver BC-639-A, Top Front Oblique, R. F. and Oscillator Assembly

70-ohm line. If the signal generator used for testing the equipment has an output impedance of about 14 ohms, a 50-ohm ±5 per cent, non-inductive resistor placed in series with the "hot" side of the generator should be used.

25. OPERATIONAL INSPECTION.

The inspection of Radio Receiver BC-639-A should be thorough enough to determine whether or not the equipment is in proper and good working order. The operating tests should be made either in the station with which the receiver is to be used, or under the conditions where the test location, the set up of the receiver, and the operating conditions of the receiver will be as close as possible to those of the station with which the receiver is to operate. If the test is made in the station, the receiver should be left in Frame FM-39. For all other inspections or tests, first remove the receiver from Frame FM-39 as instructed in paragraph 26b, section V of this book and then go ahead with the test or inspection.

NOTE

For details of how to operate the receiver in each station see the instruction book for the radio set with which Radio Receiver BC-639-A will be operated.

a. See that all plugs are securely seated. Check headset cords. Clean all headset plugs. (A three-inch pencil eraser provides a simple means for cleaning these plugs.)

b. Be sure that the dial light glows when power is supplied to the receiver.

c. Check the power supply of the receiver. You can find out all about the power supply, either Rectifier RA-42-A, (or Rectifier RA-42-B) or Dynamotor Unit PE-100-A, in the separate instruction book for each of these units. If Dynamotor Unit PE-100-A is to be used, check the storage battery supplying this unit. Be certain that it is fully charged and supplies at least 5.5 volts to the dynamotor when operating at full load.

d. Switch the power to Radio Receiver BC-639-A ON so that the receiver is operating normally. If no station signals are available, Frequency Meter BC-638-A or Oscillator Test Equipment RC-93-A may be used to give a signal for the operating test. (Refer to the instruction book for each of these units for operating instructions if they are to be used.)

(1) Check the operation of all controls on the front panel.

(2) Check the noise level of the receiver. It should be about 5-10 mw (1.78 to .45 volts across a 600-ohm non-inductive load) with no signal input and gain controls at maximum. (*See paragraph 38.*)

(3) Check the receiver sensitivity with instructions given in paragraph 37.

(4) Check the frequency calibration with Frequency Meter BC-638-A.

(5) Check the TUNING METER. (It should read about 5 milliamperes with the R.F. GAIN INCREASE control all the way to the right and with no signal input to the receiver.)

26. DISASSEMBLY OF UNIT.

a. POWER AND ANTENNA CONNECTIONS.—The power supply cable and the 70-ohm coaxial antenna transmission line are disconnected from the RADIO RECEIVER BC-639-A by removing the plugs from their respective sockets at the rear of the receiver chassis.

b. TO REMOVE RADIO RECEIVER BC-639-A FROM STANDARD RACK MOUNTING.—Release the six roundhead machine screws which pass through the three slots at each side of the panel.

Support the unit from the front panel and remove the six screws.

Grasp the handles and lift the unit out of the frame from the front.

Remove the two bottom screws last.

Be careful not to jar the unit when removing it from the rack as jarring may injure the vacuum tubes, especially those of the 9000 series. (VT-202 and VT-203).

c. TO REMOVE DUST COVER FROM THE CHASSIS.—Unscrew the five screws along the top front edge of the dust cover *behind* the front panel.

Unscrew the two screws at each edge of the rear surface of the dust cover.

Unscrew the three screws around the antenna terminal.

A #6 Allen wrench is mounted on the chassis right rear of each receiver for Allen setscrews in the drive assembly, couplings, knobs etc.

d. TO REMOVE ELECTRICAL ASSEMBLIES FROM CHASSIS.

(1) OSCILLATOR ASSEMBLY.—Remove the oscillator assembly (274) from the chassis as follows: (*BE VERY CAREFUL NOT TO DAMAGE IT WHILE REMOVING.*)

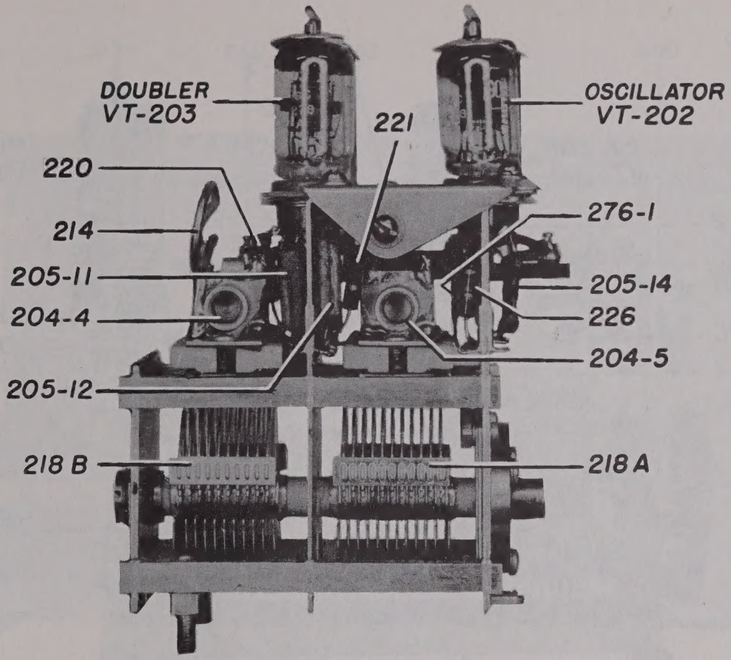


Figure 9 — Radio Receiver BC-639-A, Left Side View, Oscillator Assembly

(*a*) Facing the front panel, locate the two wires, one red and one brown, coming to the terminal strip on the top of right side of the oscillator tuning gang from below the chassis. Unsolder these two wires from the terminal strip, *making a careful note of where they are connected.*

(*b*) Remove the small ground strap connecting the radio frequency tuning gang and the oscillator tuning gang. This strap is located between the oscillator and r-f. Amplifier tubes on the top front of the two capacitor gangs. This strap is held at each end by a small screw with plain washer.

(*c*) Loosen the two adjacent (on the same coupler) Allen setscrews in the flexible coupler which connects the capacitor shaft to the drive assembly. (To loosen the setscrews use the Allen wrench mounted on the receiver chassis.)

(*d*) Remove the two nuts and one screw below the chassis which hold the oscillator assembly to the chassis.

(*e*) Lift up and back, until the capacitor shaft clears the coupler and then remove the assembly from the receiver.

(2) RADIO FREQUENCY ASSEMBLY.—Remove radio-frequency assembly (275) from the chassis as follows: CAUTION: BE CAREFUL NOT TO DAMAGE IT WHILE REMOVING. BE VERY CAREFUL NOT TO BEND ANY OF THE COILS AND DO NOT TOUCH THE TRIMMER CAPACITORS.

(*a*) Locate the four wires coming from below the chassis to the terminal strip on the left side of the radio frequency tuning gang. Unsolder these wires from the terminal strip. *Make a careful note of where they are connected.*

(*b*) Locate the two wires coming from the first intermediate frequency transformer (Ref. No. 231) to the radio frequency assembly. Unsolder these wires after making a *careful note of where they are connected.*

(*c*) Locate the two red wires coming from below the chassis to the corner of the terminal board. Unsolder these wires after *making a note of where they are connected.*

(*d*) Locate the antenna lead-in pipe. Unsolder the antenna wire and the antenna shielding pipe from the radio frequency assembly.

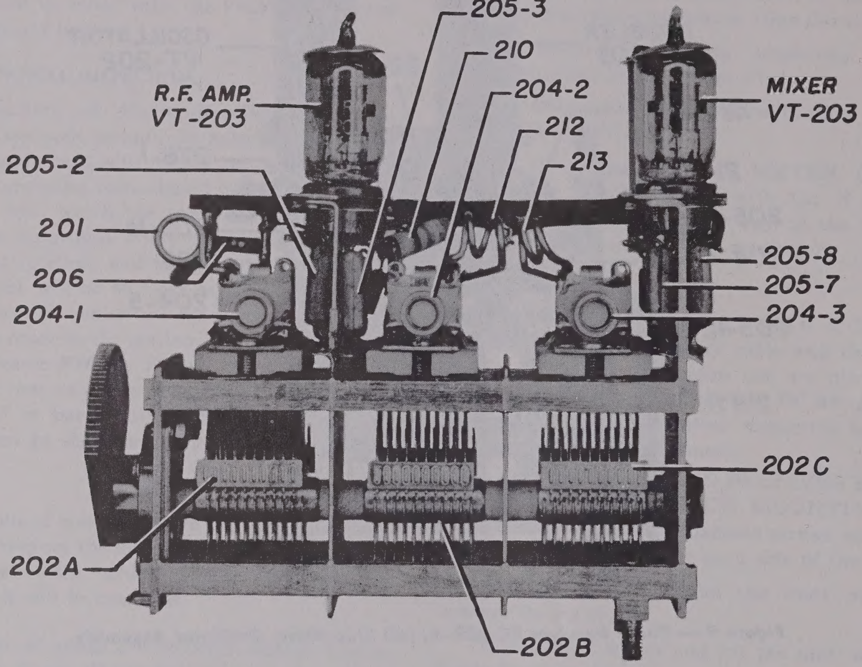


Figure 10 — Radio Receiver BC-639-A, Right Side View, R. F. Assembly

(*e*) Remove the small ground strap connecting the radio-frequency tuning gang to the oscillator tuning gang. This strap is at the top of the tuning gangs and is held by a screw with a plain washer at each end of the strap.

(*f*) Remove the two nuts and one screw, below the chassis, which hold the radio frequency assembly to the chassis.

(*g*) Slide the complete radio-frequency assembly toward the rear of the receiver, disengaging the two quadrant gears.

(*h*) Lift the assembly out of the receiver chassis.

NOTE

Remove the oscillator assembly from the receiver chassis before removing the radio-frequency assembly. In this way the edge of the radio-frequency assembly is moved to one side, thus clearing the antenna lead-in pipe.

(3) INTERMEDIATE FREQUENCY TRANSFORMER ASSEMBLIES.—First intermediate frequency transformer.

Unsolder all wires connected to the four terminals on the bottom of the chassis.

On the first intermediate frequency transformer unsolder the two wires on the top of the chassis, one of which is connected to the grid of the mixer tube and the other to the three gang capacitor frame.

Remove the two #6-32 hexagonal nuts and lift the assembly from the top of the chassis.

(4) SECOND, THIRD, FOURTH INTERMEDIATE FREQUENCY TRANSFORMER ASSEMBLIES.—Unsolder all wires leading to each of the four terminals on the bottom of the chassis.

Remove the two #6-32 hexagonal nuts.

Lift the assembly from the top of the chassis.

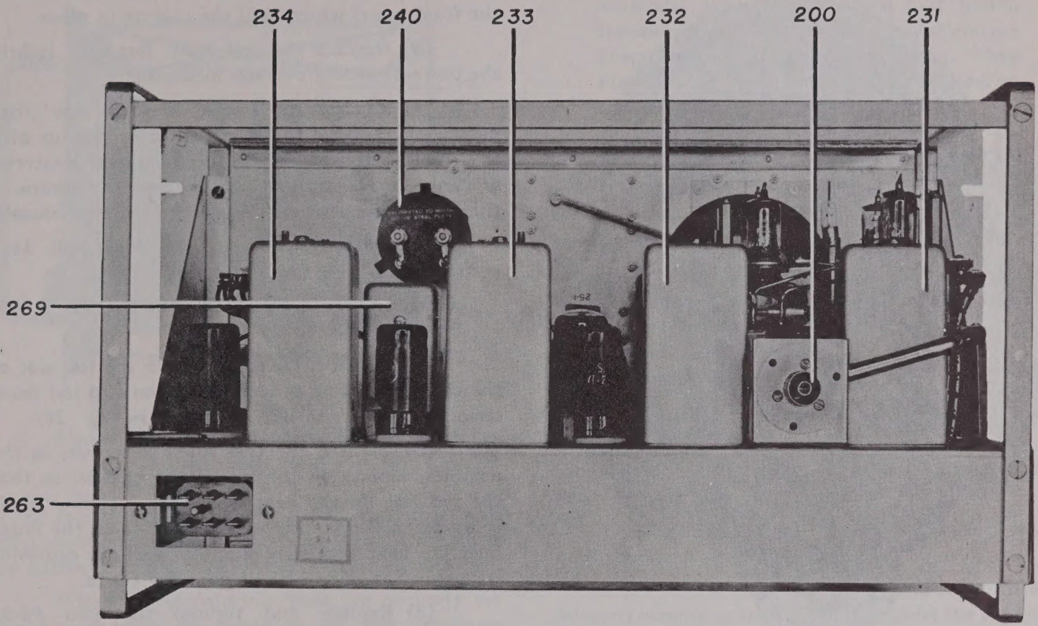


Figure 11 — Radio Receiver BC-639-A, Rear View, Dust Cover Removed

Make a careful note of the way the four transformer cans are placed on the chassis of the receiver, the 1st and 4th transformer cans are placed so that the terminals #3 and #4 are next to the back of the receiver chassis. The second and third transformer cans are placed so that terminals #1 and #2 are next to the back of the receiver chassis.

(5) BEAT FREQUENCY OSCILLATOR ASSEMBLY (272).—Unsolder the wires from the three terminals of the oscillator assembly can and remove the two #6-32 round-head screws.

Loosen the two Allen setscrews in the flexible coupling on the top of the chassis. (*An Allen wrench is mounted on the chassis for this purpose.*)

The assembly may now be removed from the top side of the chassis.

(6) GEAR DRIVE ASSEMBLY.—A large tuning control knob on the front panel must be removed before the gear drive assembly can be removed from the chassis. This knob has two holes, set at a 90° angle, cut into its side.

The knob must be turned against its clutch until the holes line up and an Allen setscrew can be seen by looking down into each hole.

When the holes are lined up with the setscrews, the Allen wrench, mounted on the receiver chassis, may be inserted and the two #6-32 Allen setscrews loosened.

Remove this knob from the front panel.

Remove the dial light which is held firmly in place by two screws and oversize lockwashers, fastening into a slot for easier adjustment.

Remove the three binder-head screws on the front panel which hold the casting in place.

Remove the anti-backlash spring from the dial tie wire.

Loosen the setscrews on the coupling of the two gang assembly.

Lift the complete gear drive assembly from the receiver.

(7) AUDIO TRANSFORMER ASSEMBLY (258).—Unsolder all the wires from the five terminals on the bottom of the chassis.

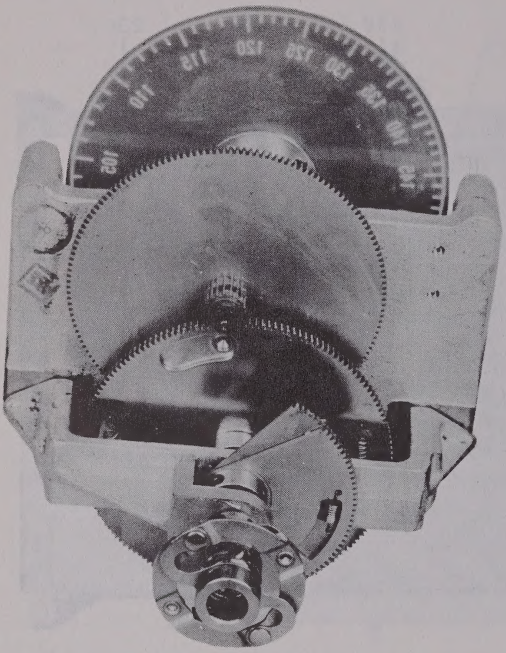


Figure 12 — Radio Receiver BC-639-A, Dial Drive Gears

Remove the four #6-32 round-head mounting screws and lift the transformer from the chassis.

27. REASSEMBLY OF UNIT.

a. TO REPLACE ELECTRICAL ASSEMBLIES ON CHASSIS.

(1) AUDIO TRANSFORMER ASSEMBLY (258).—Replace the transformer can in the chassis; be very careful to get it just as shown in the wiring diagram.

Resolder all wires to the five terminals on the bottom of the chassis, these connections are shown in the wiring diagram.

Replace the four #6-32 roundhead mounting screws which hold the transformer to the chassis.

(2) GEAR DRIVE ASSEMBLY.

(*a*) Replace the gear drive assembly in the receiver chassis and tighten the setscrews on the coupling of the two gang assembly.

(*b*) Replace the anti-backlash spring on the dial tie wire.

(*c*) Replace the three binder-head screws on the front panel which hold the casting in place.

(*d*) Replace the dial light, fastening tightly the two screws and oversize lockwashers.

(*e*) Replace the tuning knob on the front panel, making sure that the two holes line up with the Allen setscrews. When the holes and setscrews are lined up, fasten the two setscrews by means of the Allen wrench mounted on the receiver chassis.

(*f*) Align as explained in paragraph 34c., section V.

(3) BEAT FREQUENCY OSCILLATOR ASSEMBLY (272).

(*a*) Replace this assembly on the top side of the chassis, making proper connections to the three terminals. (*See the wiring diagram. fig. 24*)

(*b*) Tighten the two Allen setscrews, in the flexible coupling on the top of the chassis, so that the red line on the beat frequency oscillator shaft is *up* when the pointer of the knob is on the index line. The beat frequency oscillator variable capacitor is now in the middle of its capacity range.

(*c*) Replace and tighten the two #6-32 round-head screws, which hold the assembly in the chassis.

(4) INTERMEDIATE FREQUENCY TRANSFORMER ASSEMBLIES.—In replacing the first and fourth transformer cans in the chassis be sure that terminals 3 and 4 are next to the back

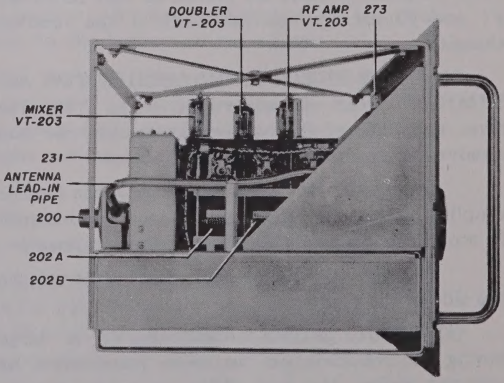


Figure 13 — Radio Receiver BC-639-A, Left Side View

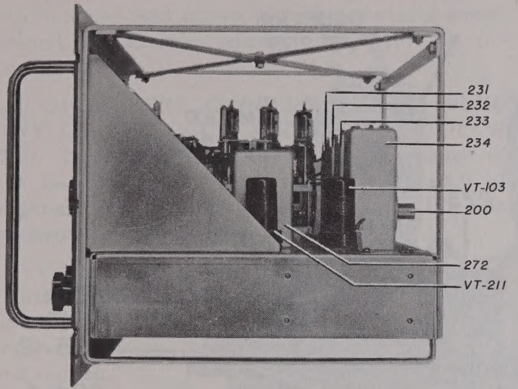


Figure 14 — Radio Receiver BC-639-A, Right Side View

of the receiver chassis. In replacing the second and third transformer cans be sure that terminals 1 and 2 are adjacent to the back of the receiver chassis.

When the transformer cans are properly set resolder all wires connected to the four terminals at the bottom of the chassis.

Replace the two #6-32 hexagonal nuts which hold the assemblies to the chassis.

In replacing the first transformer assembly resolder the two wires on the top of the chassis (coming from the side of the can), the green wire is connected to the grid of the mixer tube and the other wire is connected to the three gang capacitor frame.

CAUTION

DO NOT TIGHTEN SPADELUGS TOO TIGHTLY AS THEY WILL TWIST OFF THE ASSEMBLY.

After reassembly, align the intermediate frequency transformer assemblies as described in paragraph 34*a*., section V.

NOTE

It is very important that all intermediate frequency transformers are properly placed with reference to the terminal numbers on the bottom of the assembly. (See paragraph 34*a*., section V and the wiring diagram fig. 24.) The first and second intermediate frequency transformers are *over-coupled* but are not otherwise similar. The third and fourth transformers are *critically-coupled* and are exactly alike except for stenciling. They may be interchanged if properly placed on the chassis.

(5) OSCILLATOR ASSEMBLY (274).

(*a*) Replace the oscillator assembly in the chassis making sure that the capacitor shaft is inserted in the coupler.

(*b*) Replace the two nuts and one screw below the chassis which hold the oscillator assembly to the chassis.

(*c*) Tighten the two Allen setscrews next to it in the flexible coupler which connects the capacitor shaft to the drive assembly.

(*d*) Replace the ground strap connecting the radio frequency tuning gang and the oscillator tuning gang.

(*e*) Fasten the small screw and washer which hold the strap at each end.

(*f*) Replace the two wires (*one red and one brown*) coming to the terminal strip on the top-right side of the oscillator tuning gang from below the chassis.

(*g*) Align the oscillator assembly in connection with the radio frequency assembly as explained in paragraph 34*d*., section V.

(6) RADIO FREQUENCY ASSEMBLY (275).

(*a*) Replace the radio frequency assembly in the receiver chassis *making sure that the two quadrant gears are engaged.*

(*b*) Replace the two nuts and one screw, (below the chassis) which hold the radio frequency assembly to the chassis.

(*c*) Replace the ground strap connecting the radio frequency tuning gang to the oscillator tuning gang. This strap is held by a screw and plain washer at each end of the strap.

(*d*) Resolder the antenna wire and antenna shielding pipe to the assembly.

(*e*) Resolder the two *red* wires coming from below the chassis to the corner of the terminal board located at the left side of the radio frequency assembly.

(*f*) Resolder the two wires coming from the first intermediate frequency transformer to the radio frequency assembly.

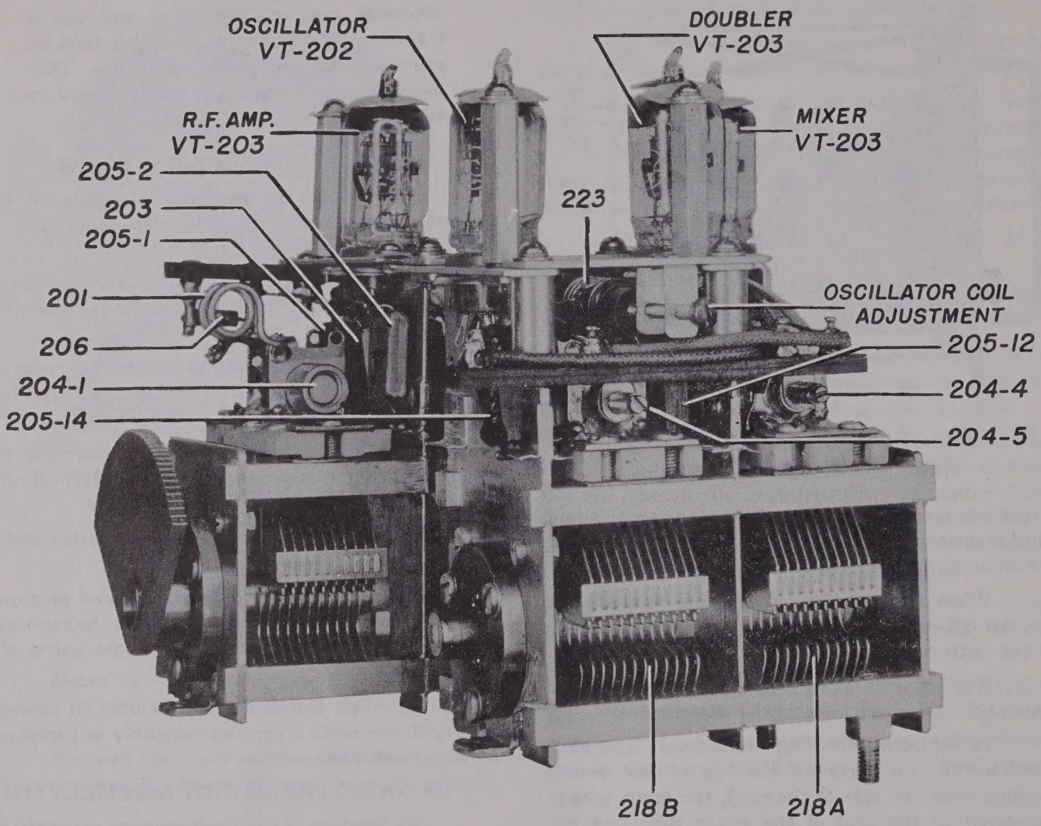

OSCILLATOR VT-202
DOUBLER VT-203
R.F. AMP. VT-203
MIXER VT-203
205-2
203
223
205-1
201
OSCILLATOR COIL ADJUSTMENT
206
205-12
204-1
204-4
205-14
204-5
218 B
218 A

Figure 15 — Radio Receiver BC-639-A, Front Oblique, R. F. and Oscillator

(*g*) Resolder the four wires coming from below the chassis to the terminal strip at the left side of the radio frequency tuning gang.

(*h*) Align the radio frequency assembly in connection with the oscillator assembly as explained in paragraph 34*d*., section V.

b. TO REPLACE DUST COVER ON CHASSIS.

(1) Fasten the five screws along the *top front edge* of the dust cover *behind* the front panel.

(2) The five screws along the *bottom front edge* of the dust cover *behind* the front panel.

(3) The two screws on each edge of the rear surface of the dust cover.

(4) The three screws around the antenna terminal.

c. TO REPLACE RADIO RECEIVER BC-639-A IN STANDARD RACK MOUNTING.—Grasp the handles mounted on the front panel and slide the unit into the rack mounting from the front. Replace and fasten the six roundhead machine screws which pass through the three slots at each side of the panel.

d. POWER AND ANTENNA CONNECTIONS.—Replace the power supply cable in the socket provided for it at the rear of the chassis. Replace the 70-ohm coaxial transmission line from the antenna in the antenna socket at the rear of the unit.

28. ROUTINE INSPECTION AND OVERHAUL.

a. GENERAL.—Remove the receiver from the rack by removing the six screws holding the panel to the rack.

(1) Remove the dust cover by removing the fifteen round-head screws, including the three screws around the antenna terminal, holding it on the chassis.

(2) *BE VERY CAREFUL NOT TO BEND ANY OF THE COILS AND DO NOT TOUCH THE TRIMMER CAPACITORS.* The shape of the small coils may be distorted, as a result of alignment adjustments of the receiver. *Do not attempt to change their shape.*

(3) Inspect all nuts, bolts, and screws for tightness. Do not tighten glyptalled screws or nuts unless you see that they are loose. If they are loose, remove the screws or nuts, apply glyptal, replace, and tighten.

(4) Remove loose solder, dirt, and metallic chips. Clean the equipment thoroughly and touch up scratched paint.

(5) Remove all traces of corrosion.

(6) Inspect soldered joints and wiring. If more than two strands are broken at a soldered joint, resolder the connection.

(7) Remove all plug connectors and clean if necessary.

CAUTION

While making the above inspections, do not disturb alignment adjustments or wiring unless absolutely necessary.

b. Check all tubes using Supreme Tube Tester, Model 504-A, or any tube tester which will test the type tube used in the receiver, in accordance with the instructions provided with the instrument. See that all tubes are securely mounted in their sockets. When replacement is necessary, follow the instructions given in paragraph 40, section V.

c. TUNING MECHANISM.—Remove all dirt and old grease. Lubricate gears and tuning shaft coupling as described in paragraph 30, section V.

d. TUNING CAPACITOR.—Inspect for dirt between the plates. Clean carefully with a pipe cleaner. *Be careful not to bend plates.* DO NOT LUBRICATE. *Do not blow out as the air hose may contain water or produce sufficient pressure to bend the plates.*

e. Test as in paragraph 31, section V, if there is any reason to think that performance is not normal.

CAUTION

DUST ON THE HIGH FREQUENCY COMPONENTS OF THIS RECEIVER MAY DECREASE THE SENSITIVITY. REMOVE THE DUST COVER ONLY WHEN ABSOLUTELY NECESSARY. PUT THE DUST COVER BACK AS SOON AS YOU CAN. BE SURE THE 15 DUST COVER SCREWS ARE ALL TIGHT AS THE ELECTRICAL SHIELDING OF THE COVER WILL BE LESSENED IF GOOD CONTACT IS NOT MADE BETWEEN THE COVER AND THE RECEIVER CHASSIS AND PANEL.

29. INSPECTION AFTER OVERHAUL OF EQUIPMENT.

Repeat operational inspection as detailed in paragraph 25, section V, after making the routine checks or overhauling procedure listed in paragraph 28, section V.

30. LUBRICATION.

Do not lubricate the variable tuning capacitor, potentiometers, or any trimmer adjustments. Lubricate the tuning gear mechanism as follows:

a. Lubricate the assembly with Royco No. 6A or Andok "C" grease, available at the depot maintenance station.

NOTE

Lubrication should not be necessary for about one year of normal use. There will be no danger of the grease producing an effect on the tuned circuit. Take the same care when lubricating the dial drive assembly as in all other operations or maintenance procedures carried out on this receiver.

31. TROUBLE LOCATION AND REMEDY OF FAULTS.

You can find open and short circuits more easily if, instead of testing at random points, an orderly plan is followed. Using the schematic and wiring diagrams for guidance, (figs. 22, 23 and 24) test one part of a circuit at a time. Check each element in that part for open circuits and grounds by measuring the resistance from point-to-point with the voltohmmeter provided in the station. If measured values of resistance agree with the resistance chart in paragraph 33, section V, that particular part of the circuit is probably not at fault and needs no further atten-

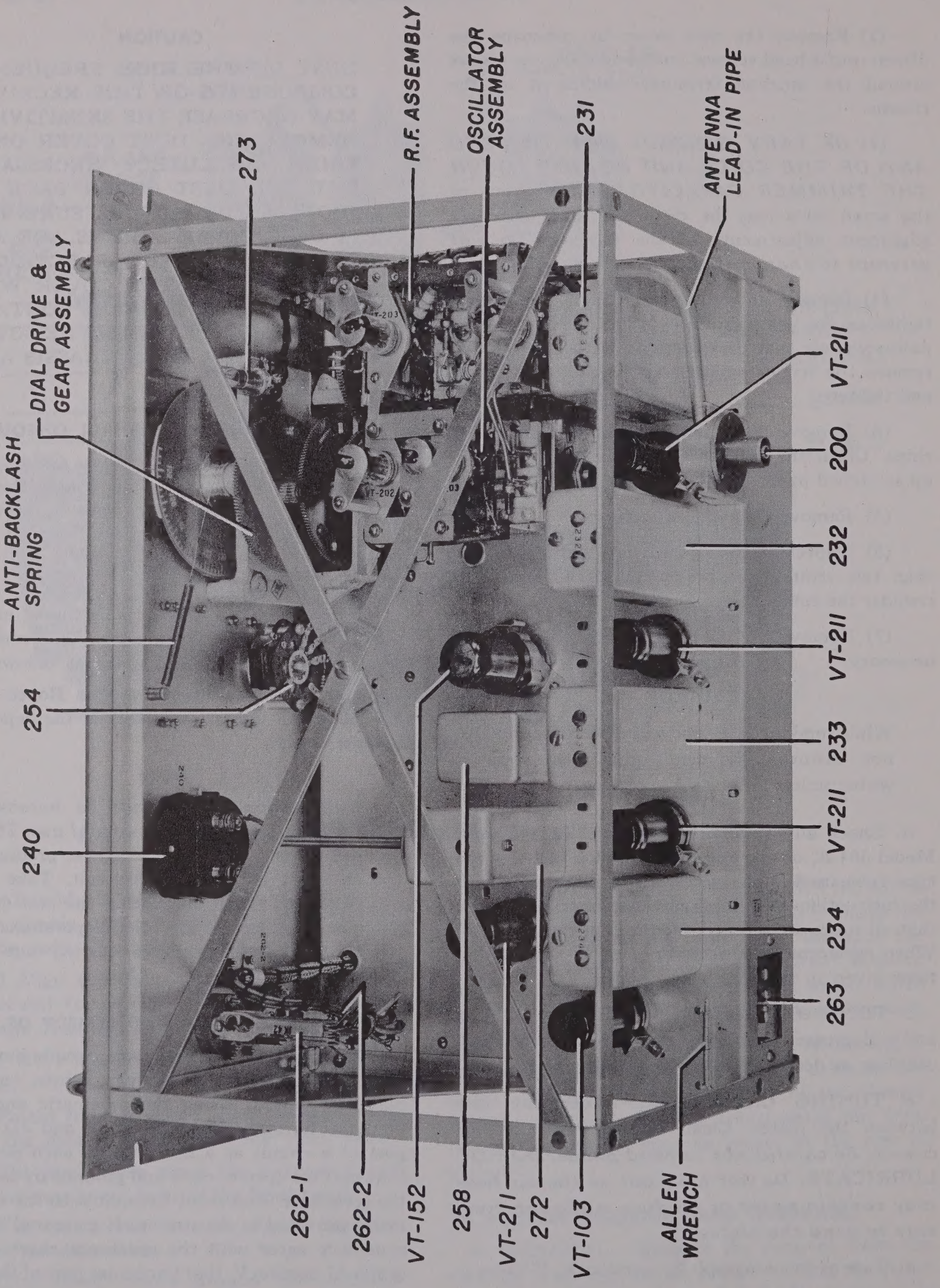

DIAL DRIVE & GEAR ASSEMBLY
273
R.F. ASSEMBLY
OSCILLATOR ASSEMBLY
231
ANTENNA LEAD-IN PIPE
VT-211
200
ANTI-BACKLASH SPRING
232
VT-211
254
233
240
VT-211
234
263
262-1
262-2
VT-152
258
VT-211
272
VT-103
ALLEN WRENCH
VT-203
VT-202

Figure 16 — Radio Receiver BC-639-A, Rear Oblique, Top View

tion. The identifying symbols of all components are given on the diagrams and their normal values can be found by reference to the Table of Replaceable Parts, paragraph 44, section VII.

	Symptom	*Probable Cause of Trouble*
1.	Broad tuning.	I-f's improperly aligned. Very strong signal.
2.	Dead spot.	Improper r-f or oscillator alignment. Defective oscillator tube.
3.	Excessive hum.	Defective power supply.
4.	Noise with antenna connected but no noise with antenna disconnected.	Defective antenna transmission line. Noisy electrical equipment in station, (check fluorescent light). Gasoline engines or electrical equipment located within 500 ft. of antenna.
5.	Noise with antenna disconnected.	Loose or poorly soldered connections. Poor or corroded ground connections. Noisy or defective tubes. Leaky fixed capacitor. Defective resistor.
6.	Signal distorted or muffled.	Defective high frequency oscillator tube. Leaky capacitor 230-18. Defective audio output tube. C.W. AND MANUAL, MANUAL, A.V.C. switch at MANUAL when strong signal is being received. C.W. AND MANUAL, MANUAL, A.V.C. switch at C.W. AND MANUAL.
7.	Signal weak.	Defective tubes. Low plate voltage from power supply. Defective antenna transmission line. Improper alignment. Threshold Sensitivity not properly adjusted.
8.	Signal weak at one end of dial.	R-f improperly aligned. Defective oscillator or doubler tube.
9.	Stations not received at proper points on dial.	R-f aligned at wrong frequency. I-f aligned at wrong frequency. Capacitor gears improperly adjusted.
10.	Vacuum tubes VT-202 and VT-203 frequently need replacing.	Filament voltage too high. Excessive vibration.
11.	TUNING METER indicates 5 MA but does not dip when receiving signal.	Defective C.W. AND MANUAL, MANUAL, A.V.C. switch. Switch in MANUAL Position. Defective capacitor 215-2. Shorted capacitor 230-16.
12.	Noisy AUDIO GAIN INCREASE control.	Defective control 251. (replace).
13.	Receiver output can be heard in MONITOR jack or LINE jack but cannot be heard at terminals 11 and 12 on Jones plug.	Dirty contacts on LINE jack, 262-2. Broken connection.
14.	Impossible to hold a steady tone with C.W. AND MANUAL, MANUAL, A.V.C. switch in C.W. AND MANUAL position.	Received signal not of constant frequency. C.W. oscillator tube not warmed up. Loose connections in C.W. oscillator circuit. Varying plate voltage from the power supply.
15.	Tone very weak when C.W. AND MANUAL, MANUAL, A.V.C. switch is in C.W. AND MANUAL position.	Open capacitor 267 and 246. C.W. oscillator improperly tuned. Defective C.W. oscillator tube.

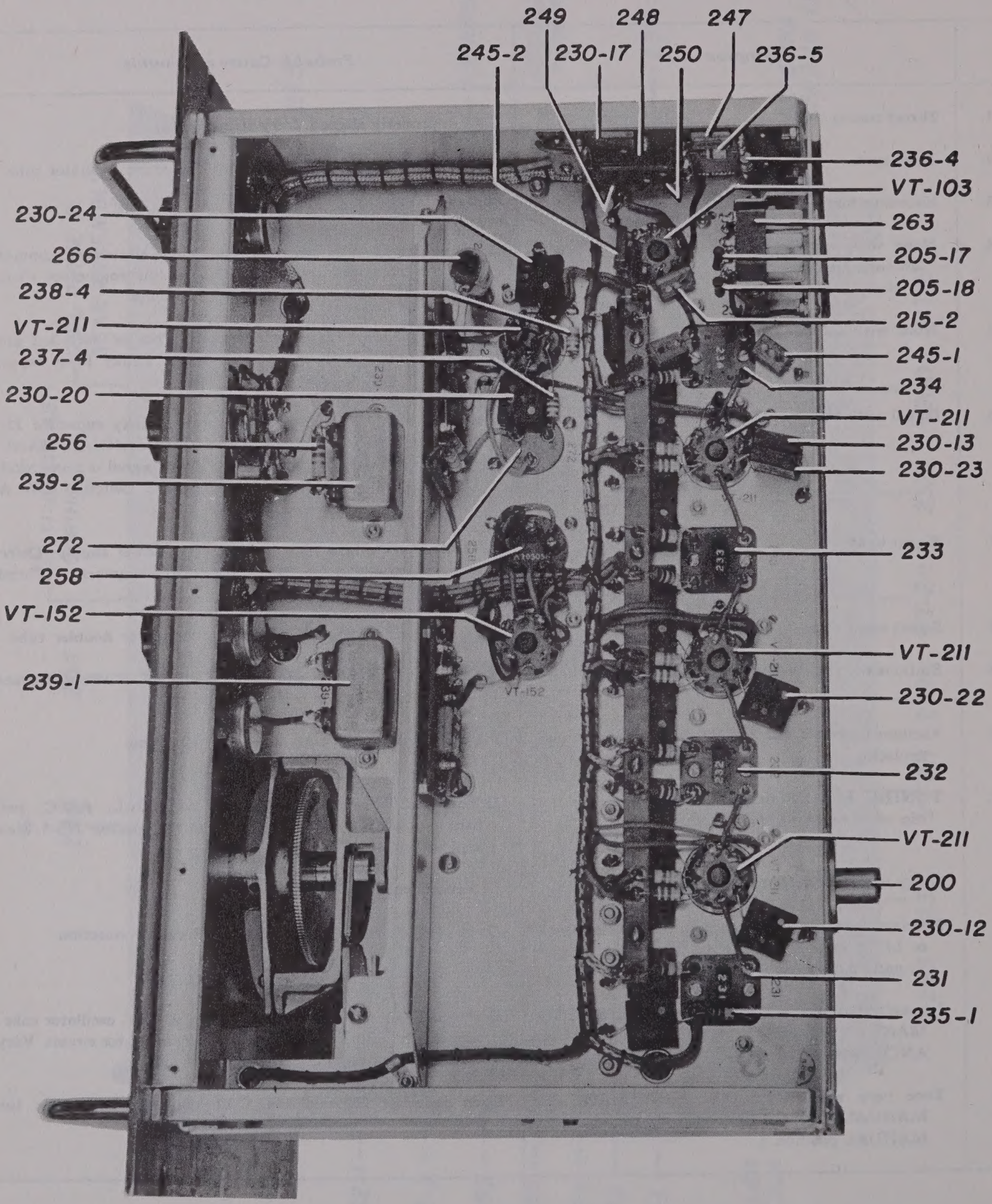

249
248
247
245-2
230-17
250
236-5
230-24
266
238-4
VT-211
237-4
230-20
256
239-2
272
258
VT-152
239-1
236-4
VT-103
263
205-17
205-18
215-2
245-1
234
VT-211
230-13
230-23
233
VT-211
230-22
232
VT-211
200
230-12
231
235-1

Figure 17 — Radio Receiver BC-639-A, Left Oblique, Bottom View

	Symptom	*Probable Cause of Trouble*
16.	Pilot lamp burns out frequently.	Excessive filament voltage. (Check this voltage as this will also shorten life of vacuum tubes.)
17.	Absolutely no output (not even noise).	Open headsets or headset cord.
18.	Normal set noise but no signal with or without antenna connected.	Defective high frequency oscillator and/or doubler.
19.	Output practically nil.	Cathode of VT-211 has a great tendency to open up.
20.	Some portion of the r.f. circuits inoperative (as determined by signal tracing).	Base of midget tubes cracked. This is usually a result of bent pins and is not easily noticed by inspection.
21.	Desired i.f. band width cannot be obtained in alignment.	Open or shorted condenser within the i.f. can. Defective i.f. tube.
22.	I.f.'s or r.f.'s won't align.	Signal generator set to wrong frequency.
23.	B+ voltage too high, poor regulation.	Bleeder resistor in RA-42-A,-B open. Usually a result of leaving the power supply turned on without a load connected.

The following tables list the average signal input needed at the grid of each of the amplifier tubes to produce a standard output of 10 milliwatts (2.45 volts) into a 600-ohm load. In comparing these measurements, connect the signal generator (Ferris 18B, 18C, 18D) or any signal generator which has a low impedance output and which can be accurately set to 11930 and 12070 kilocycles output directly to grid and ground, with the "hot" side to grid and the GND. side to the receiver chassis. *It is not necessary to break the normal grid connection to the tubes.*

For intermediate frequency measurements, use a signal of 12 mc modulated 30 per cent at 1000 cps. Keep the direct current supply voltage as close as you can to 210v for a 60 ma load, while making these measurements. Set the controls as follows:

a. C.W. AND MANUAL—MANUAL—A.V.C. at MANUAL.

b. ATTENUATION switch at 0 DB.

c. AUDIO GAIN INCREASE control at maximum clockwise position (to the right).

d. THRESHOLD SENSITIVITY control for 5 ma meter reading. See paragraph 34e, section V.

e. R.F. GAIN INCREASE control set to maximum. The control remains set at this position when the sensitivity is measured at other grids.

NOTE

Due to the audio frequency response characteristic, the input for 10mw output will be about twice the values given in the following table if 400 cps modulation is used.

Tube	*Frequency*	*Input in Microvolts for 10 mw Output (2.45 volts across a 600 ohm load)*
Mixer VT-203	12 mc	Less than 15
1st i-f VT-211	12 mc	35-70
2nd i-f VT-211	12 mc	500-1000
3rd i-f VT-211	12 mc	8000-16,000

By comparing the receiver performance with this data, the location of operational faults will be greatly facilitated. Check the stages in reverse order beginning with the last audio stage up to the radio frequency stages.

32. VOLTAGE MEASUREMENTS.

The voltages given below were taken by measuring from the tube socket terminal to ground (chassis). Rectifier RA-42-A (or Rectifier RA-42-B) supplies 210v direct current and 6.3v alternating current to the receiver. Measurements were made with both a voltmeter of 1000-ohms-per-volt sensitivity using

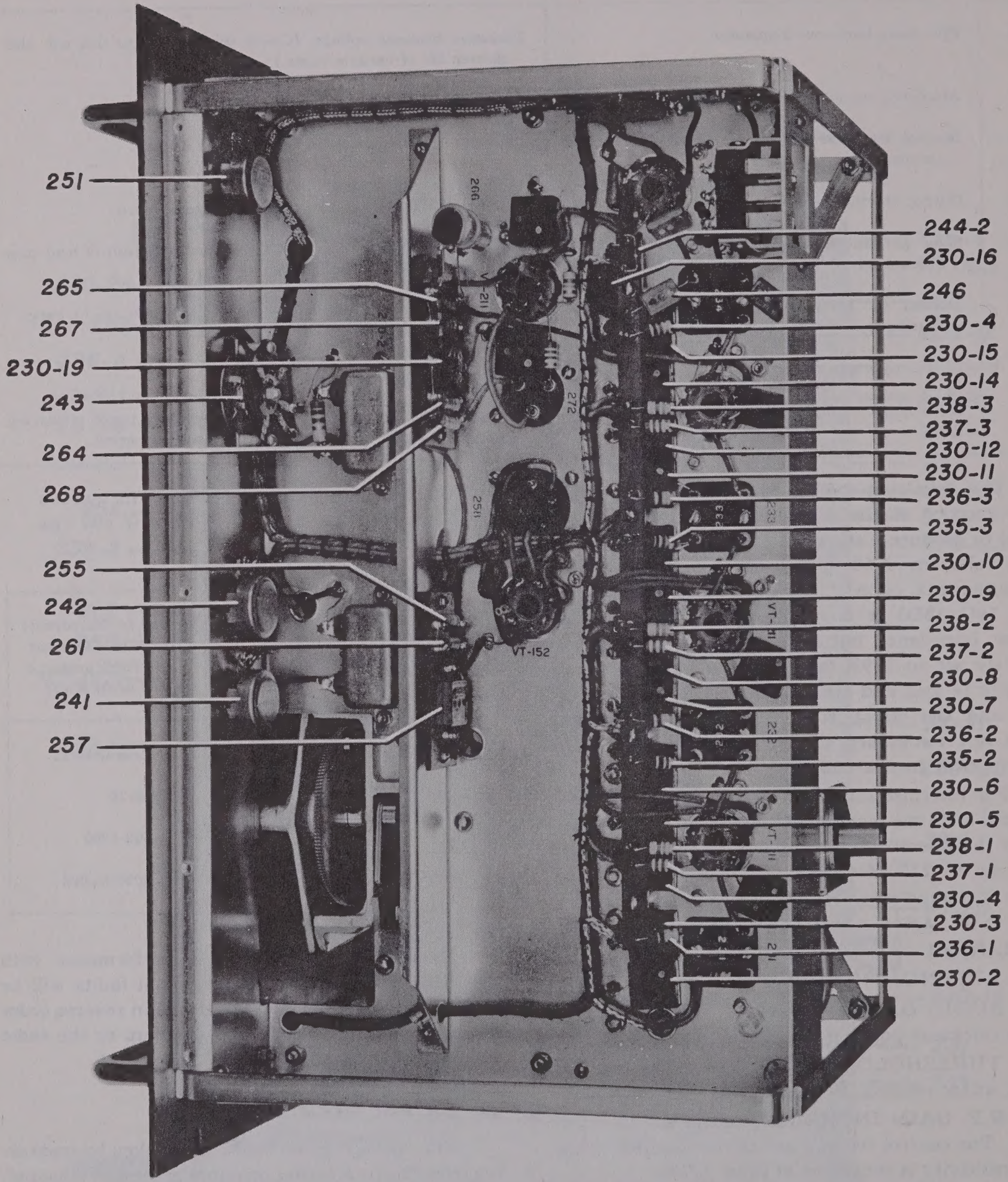

251
265
267
230-19
243
264
268
255
242
261
241
257
VT-152
244-2
230-16
246
230-4
230-15
230-14
238-3
237-3
230-12
230-11
236-3
235-3
230-10
230-9
238-2
237-2
230-8
230-7
236-2
235-2
230-6
230-5
238-1
237-1
230-4
230-3
236-1
230-2

Figure 18 — Radio Receiver BC-639-A, Rear Oblique, Bottom View

the 250v scale except where otherwise stated, and an RCA VoltOhmyst, Jr. using a range which gives about two-thirds scale deflection for the value shown. The panel control settings are the same as those specified for resistance measurements in paragraph 33, section V. See tables.

TABLE OF VOLTAGE MEASUREMENTS OF TUBES USING AN RCA VOLTOHMYST, JUNIOR.

Tube	*Function*	*Tube Socket Terminals*							
		1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
VT-203	R-F Amplifier	0	2.7	Gnd	6.3	205	93	2.7	—
VT-203	Mixer	0	2.4	Gnd	6.3	208	53	2.4	—
VT-203	Doubler	0	4.1	Gnd	6.3	190	95	4.1	—
VT-202	Oscillator	180	Gnd	6.3	Gnd	180	−5.8*	0	—
VT-211	1st I-F Amp.	Gnd	6.3	2.6	0	2.6	125	Gnd	205
VT-211	2nd I-F Amp.	Gnd	6.3	2.6	0	2.6	125	Gnd	205
VT-211	3rd I-F Amp.	Gnd	6.3	2.6	0	2.6	125	Gnd	205
VT-103	Det., 1st Audio, AVC	Gnd	6	10.0	9.5	0	145	6.3	Gnd
VT-152	2nd Audio	NC	6.3	205	210	0	NC	Gnd	19
VT-211	CW Osc.	Gnd	6.3	Gnd	−2.7*	Gnd	122	Gnd	185

*Measurement made while tube is oscillating. Underlined figures indicate a-c voltage if Rectifier RA-42-A is used.

TABLE OF VOLTAGE MEASUREMENTS USING A 1000-OHMS-PER-VOLT VOLTMETER.

Tube	*Function*	*Tube Socket Terminals*							
		1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
VT-203	R-F Amplifier	0	2.7†	Gnd	6.3†	200	93	2.7†	—
VT-203	Mixer	0	2.4†	Gnd	6.3†	205	45	2.4†	—
VT-203	Doubler	0	4.1†	Gnd	6.3†	180	95	4.1†	—
VT-202	Oscillator	140	Gnd	6.3†	Gnd	150	0*	0	—
VT-211	1st I-F Amp.	Gnd	6.3†	2.5†	0	2.5†	125	Gnd	205
VT-211	2nd I-F Amp.	Gnd	6.3†	2.5†	0	2.5†	125	Gnd	205
VT-211	3rd I-F Amp.	Gnd	6.3†	2.5†	0	2.5†	125	Gnd	205
VT-103	Det., 1st Audio, AVC	Gnd	0	5†	0.5†	0	103	6.3†	Gnd
VT-152	2nd Audio	NC	6.3†	205	210	0	NC	Gnd	20‡
VT-211	CW Osc.	Gnd	6.3†	Gnd	−0.2†	Gnd	90	Gnd	185

*High frequency oscillator grid connected to ground.
†Measured on 10v scale 1000 ohm-per-volt meter.
‡Measured on 50v scale 1000 ohm-per-volt meter.
Underlined figures indicate a-c voltage if Rectifier RA-42-A is used.

33. TYPICAL VACUUM TUBE-SOCKET RESISTANCE.

a. The values in the tables were taken from the tube socket terminal to ground (chassis) with an RCA VoltOhmyst Jr. The power supply and antenna plugs were disconnected. All tubes were in their sockets, *except for the values so designated as having been taken with the tube removed.* The controls on the front panel were set as follows:

(1) R.F. GAIN INCREASE control at maximum.

(2) AUDIO GAIN INCREASE control at maximum.

(3) ATTENUATION switch to 0 DB.

(4) C.W. AND MANUAL—MANUAL A.V.C. switch at C.W. AND MANUAL.

(5) THRESHOLD SENSITIVITY control for 5 ma meter reading.

b. TABLE OF RESISTANCE MEASUREMENTS (OHMS).

Tube	*Function*	*Tube Socket Terminals*							
		1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
VT-203	R-F Amplifier	660,000	330*	0	0.4	160,000	120,000	330	—
VT-203	Mixer	1.8 meg	1000*	0	0.4	160,000	430,000	1000	—
VT-203	Doubler	27,000	560*	0	0.4	164,000	215,000	560	—
VT-202	Oscillator	164,000*	0	0.4	0	164,000	47,000	0*	—
VT-211	1st I-F Amp	0	0.4	*200–300†	100,000	200–300†	206,000	0	160,000
VT-211	2nd I-F Amp.	0	0.4	*200–300†	100,000	200–300†	206,000	0	160,000
VT-211	3rd I-F Amp.	0	0.4	*200–300†	100,000	200–300†	206,000	0	160,000
VT-103	Det., 1st Audio, AVC	0	1.0 meg	20,000	220,000	500,000	293,000	0.4	0
VT-152	2nd Audio	NC	0.4	160,000	160,000	330,000	NC	0	1500
VT-211	CW Osc.	0	0.4	0	47,000	0	206,000	0	164,000

*Resistance is infinity when tube is not in its socket.
†Resistance value will vary with the setting of the THRESHOLD SENSITIVITY control.

c. Due to the difficulty in taking measurements on the r-f tubes (VT-202 and VT-203), the following values were obtained with the tube removed from its socket.

TABLE OF RESISTANCE MEASUREMENTS (OHMS).

Tube	*Function*	*Tube Socket Terminals*						
		1	*2*	*3*	*4*	*5*	*6*	*7*
VT-203	R-F Amplifier	660,000	Infinity	0	0.4	160,000	120,000	330
VT-203	Mixer	1.8 meg	Infinity	0	0.4	160,000	430,000	1000
VT-203	Doubler	27,000	Infinity	0	0.4	164,000	215,000	560
VT-202	Oscillator	Infinity	0	0.4	0	164,000	47,000	Infinity

d. The following measurements were taken from Jones plug terminals to ground:

Terminal No.........	7	8	9	10	11	12
Resistance (ohms)...	0	0.4	0	160,000	4800	4800

34. ALIGNMENT USING SIGNAL GENERATOR.

a. INTERMEDIATE FREQUENCY AMPLIFIER ALIGNMENT.

(1) Connect the signal generator (Ferris 18B, 18C, 18D or 16C or any signal generator which has a low impedance output and which can be accurately set to 11930 and 12070 kc) output lead directly

to the mixer tube (VT-203) control grid (front lug with a resistor and capacitor attached to it), connect the lead shield to the capacitor frame, and connect a grounding clip at about the center of the generator output lead and connect this clip to the chassis. Keep all connections from the generator to the receiver and ground as short as possible.

(2) Set the output load, and the controls as outlined in paragraph 37, section V. Turn the **THRESHOLD SENSITIVITY** control all the way to the right. Turn the power source ON and allow two or three minutes for the tubes to warm up.

(3) With the generator emitting a 5 to 10 microvolt signal at 12000 kc, modulate the signal 30% at 1000 cycles, and set the generator output high enough to hear the signal. Adjust the iron core at the tops of intermediate frequency assemblies 234 and 233 (starting from right to left with the front panel facing you) for maximum deflection of the output meter. *These transformers are critically coupled and should be accurately peaked.* The screw at the extreme right controls tuning of secondary circuit of the last i.f. transformer.

(4) Set the signal generator to 11930 kc, with modulation on as above, and adjust the iron core in the primary of intermediate frequency assemblies 232 and 231 (starting from left to right with the front panel facing you) for maximum deflection of the output meter. The primary IF coils 229-1 and 229-3 are on the right hand side at the top of the IF assemblies with the front panel facing you (see fig. 22, section VII, drawings).

(5) Set the signal generator to 12070 kc and proceed as outlined in sub-paragraph 4 above to adjust the iron core in the secondary of intermediate frequency assemblies 232 and 231. The secondary IF coils 229-2 and 229-4 are located on the left hand side at the top of the IF assemblies and are also shown (see fig. 22, section VII, drawings). Loading or detuning of secondaries while aligning primaries, or of primaries while aligning secondaries may be necessary. The signal output is then noted as the signal generator is tuned between 11930 and 12070 kc's, and if the variation is too great, the alignment procedure is repeated until the proper flat-topping results, with a rapid falling off of output indicated when the signal generator is set to a frequency beyond the given limits. If an oscilloscope and a sweep signal generator is available the visual method can be used to insure the proper intermediate frequency amplifier characteristics required for broad band alignment.

(6) Adjust the signal generator output and the R.F. GAIN INCREASE control for 10 to 1 signal to noise ratio. [See paragraph 37*b*(6), section V].

With this setting of the controls and generator, repeat steps (3) to (6) above.

When properly aligned, the intermediate frequency transformers should have a sensitivity at 10 to 1 signal-to-noise ratio of better than 15 microvolts (usually around 10 microvolts), and the output meter should show about the same rise and fall on both sides of 12 mc. as the generator is tuned from one side of resonance to the other.

Note

While it is desirable to obtain 12 mc for the center of the intermediate frequency band, no difficulty will be experienced in operation of the receiver if a deviation occurs up to ½ mc; as long as all intermediate frequency transformers and the beat frequency oscillator are aligned relative to this new center frequency. It is important that the first and second intermediate frequency transformers are aligned at 70 kc above and 70 kc below the center frequency. (70 kc is represented by approximately 1.4 scale divisions on a Ferris 18D signal generator). NOTE: *Always approach the desired signal generator dial setting from a lower dial setting, even when resetting from a higher dial reading. This minimizes setting inaccuracies caused by the mechanical back-lash.*

b. BEAT FREQUENCY OSCILLATOR ALIGNMENT.—After you have completed the intermediate frequency alignment, the beat frequency oscillator alignment should follow, and no changes should be made in the set-up. Use the same set-up as used for intermediate frequency.

(1) Set the C.W. AND MANUAL, MANUAL, A.V.C. switch to C.W. AND MANUAL. Set the C.W. TONE CONTROL pointer to the index line at the center of the arrowed line. With the pointer set at the index line, the *red* line on the shaft attached to the rear coupler should be up.

(2) Set the signal generator to 12 mc. and turn the modulation OFF. Set multiplier and attenuator for maximum radio frequency output.

(3) Insert a screwdriver through the opening in the beat frequency oscillator assembly (272) to the left of the C.W. oscillator Tube VT-211. Turn this screw until a zero-beat is obtained. Without changing any setting, turn the C.W. TONE CONTROL to the right or left to give about a 1000-cycle pitch, or set the control for maximum audio output.

(4) With a screwdriver, turn the C.W. oscillator plate coil iron core screw, on the chassis to the right and in front of the VT-211 tube, until you get maximum output. Turn the screw one turn clockwise (*to right*) past this maximum point. This proves the overall stability of the receiver in the C.W. position. The oscillator portion operates at 6 mega-

cycles and is variable. The plate circuit of the oscillator tube is tuned to 12 megacycles. The oscillator tube therefore operates as both an oscillator and a frequency doubler.

c. GEAR AND TUNING CAPACITOR ALIGNMENT.

(1) The quadrant gear in the gear drive assembly should be tightened to its shaft in such a position that it does not touch the casting when the tuning knob is moved from stop to stop.

(2) The tuning knob should be rotated counterclockwise (*to the left*) and held against the stop. The dial should be turned until the line marked STOP is at the index on the dial window. Tighten the two set screws in the dial hub.

(3) The two quadrant gears (one mounted on the drive and the other on the three gang capacitor assembly) should be meshed so that when the tuning knob is in the extreme counterclockwise position, the top edges of these gears are about parallel to the chassis.

(4) Turn the tuning knob clockwise until the line on the dial marked ALIGN is at the index on the window. The dial is held in this position until both capacitors (two gang and three gang) are set full mesh. To set the capacitors, turn them with respect to their quadrant gear. For the three gang, you can do this by loosening the two Allen set screws in the hub of the quadrant gear. For the two gang capacitor, the set screws in the coupling can be loosened. Tighten all set screws and check to see that both capacitors are in full mesh when the dial is set at ALIGN. No other gear adjustment is needed.

d. RADIO FREQUENCY AND HIGH FREQUENCY OSCILLATOR ALIGNMENT.—CAUTION: *The alignment of the tuned radio frequency and high-frequency oscillator circuits are the most difficult operations to perform in the maintenance of the receiver. Only skilled, trained personnel having the necessary tools should attempt this alignment. It is emphasized again that indiscriminate adjustments or carelessness may seriously damage the receiver.*

The quadrant gears must be properly placed and set, and the capacitors set at a predetermined point before proceeding to align the radio frequency portion of the receiver. Check these settings carefully as follows:

(1) Turn the dial mechanism to ALIGN.

(2) The rotor (moving) plates of the three gang capacitor must be flush with the stator (fixed) plates at the left side of the capacitor, looking at it from the front of the receiver. If resetting is required, loosen the quadrant gear where it is attached to the three gang shaft by loosening the two set screws and moving the capacitor plates until they are lined up. An Allen wrench is attached near the right rear top corner of the chassis for this purpose. If any set screw is loosened put a small amount of glyptal on the threads of the screw before retightening it.

(3) The rotor plates of the two gang capacitor must be flush with the stator plates at the right side of the capacitor, looking at it from the front of the receiver. If resetting is required, loosen the set screws on the front of the coupler, with the Allen wrench, reset the capacitor, put a small amount of glyptal on the screw threads, and retighten the set screw.

NOTE

It may be impossible to reset the capacitor plates so that they are flush at the edges. The set screw will make a groove in the capacitor shaft when it is tightened and unless it is possible to reset the capacitor so that the setscrew is moved at least one-half the diameter of the groove, it is best to leave the capacitor at the old setting provided the difference is not more than one sixty-fourth of an inch from the flush point. If you are off a little from the flush setting it will not seriously affect the final overall performance of the receiver.

(4) The tools required to make the radio frequency alignment correctly are:

An insulated screwdriver for trimmer adjustments.

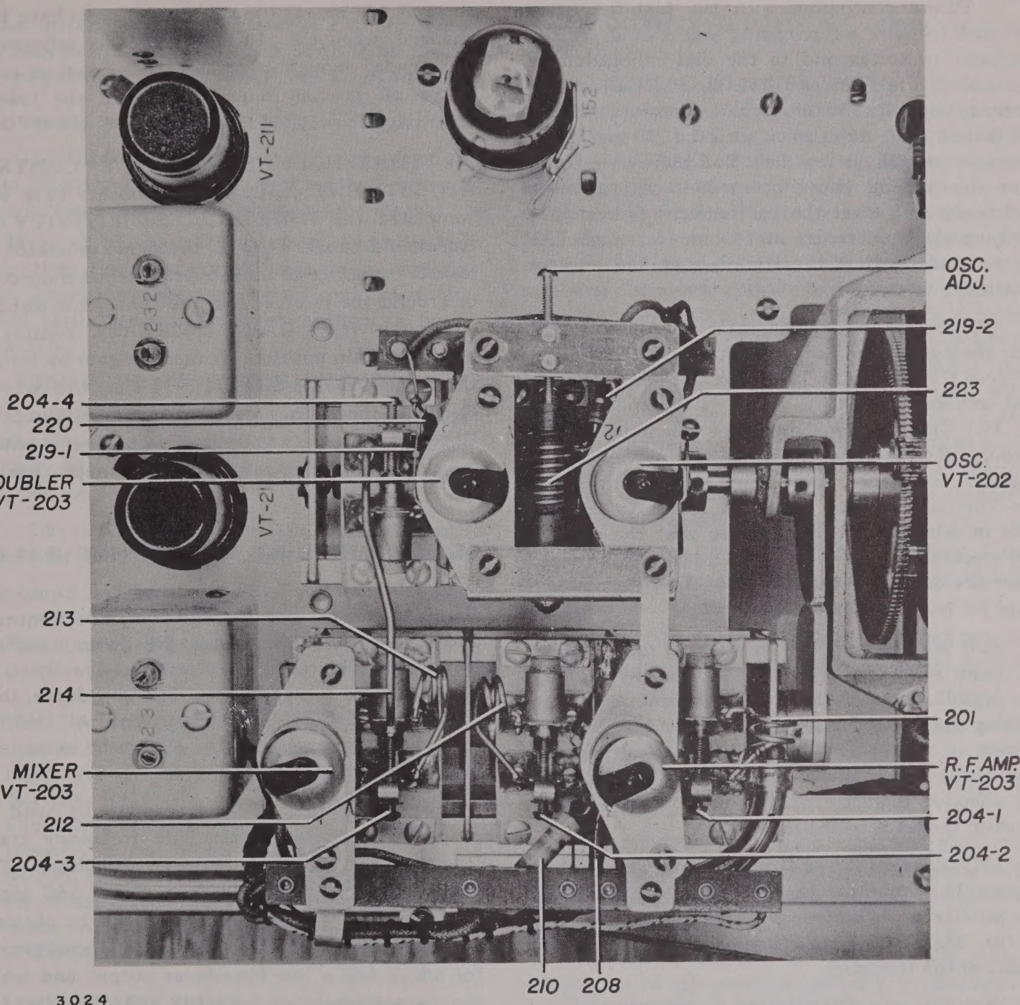
A pair of bakelite or fibre tools about $\frac{1}{4}$ x $\frac{1}{2}$ inch and about 4 to 6 inches long with a tapered point at one end to adjust the inductances.

A pair of long-nose pliers with insulated jaws or the jaws cut off and baklite jaws added.

(5) Connect the terminated line from the signal generator to the antenna plug of the receiver, connect the receiver to the power source, and set the controls as covered in paragraph 37*b*, section V.

(6) Turn the THRESHOLD SENSITIVITY control full ON, (to the right). Turn the R.F. GAIN INCREASE control full ON.

Revised 24 December 1951


VT-211
VT 152
OSC.
ADJ.
219-2
223
204-4
220
219-1
DOUBLER
VT-203
VT-2'
OSC.
VT-202
213
214
201
MIXER
VT-203
R.F. AMP.
VT-203
212
204-1
204-3
204-2
210
208

3024

Figure 19 — Radio Receiver BC-639-A, Top View, R. F. and Oscillator Assembly

(7) Set the signal generator to 156 mc, modulated 30% at 1000 cycles.

It will usually be necessary to use a high output from the generator to start, and reduce it, and the R.F. GAIN INCREASE control, as the various stages are brought into resonance.

Set the receiver dial to 156 mc.

Adjust the oscillator trimmer (204-5) (lower screw on the front section of the two gang capacitor) until the signal is heard in the headset. (See fig. 15.) Adjust all other high frequency trimmers (reference nos. 204-4, 204-1, 204-2, and 204-3), for maximum deflection of the output meter. (*See figs. 15 and 19*).

(8) Set the signal generator and receiver to 100 mc. and adjust the inductance of the oscillator coil (top screw on the front section of the 2-gang condenser) until the signal is heard. (See figure 19.) Adjust the inductances of all high frequency coils by squeezing them together or spreading them apart, using the insulated tools, for maximum meter deflection of the output meter.

Before continuing with the high-frequency coil and trimmer adjustments, you should set the oscillator to correspond to the dial calibration at the end points (156 and 100 mc.). Readjust the trimmer until the 156 mc. signal comes in at 156 on the dial, and the inductance until the 100 mc. signal comes in at 100 on the dial. You may have to go over this several times before the calibration is accurately set. After the calibration has been set, readjust the inductances at 100 mc. for maximum output and readjust the trimmers at 156 mc. for maximum output.

(9) Set the signal generator to 130 mc. and tune the signal in on the receiver. Adjust the spacing between the r-f plate coil Ref. No. 212 and the mixer grid coil Ref. No. 213 to about ¼ inch apart. (See fig. 19.) The exact spacing is set when the output reading decreases as the coils are moved either together or further apart. This adjustment is for the "mutual" setting only and serves to set the coils in relation to each other so that the circuits will track as the receiver is tuned across the range. Place the hair-pin coil (see fig. 19) from the doubler stage for maximum output.

(10) After setting the coils at 130 mc. readjust the inductance of the coils at 100 mc. by moving the outside turns of the coil for maximum output holding the inside turn so that it does not move in respect to the other coil. Adjust the hairpin coil from the doubler for maximum output by changing the effective diameter of the loop or the spacing between the leads to the loop.

(11) Repeat (8) and (10) above until no further increase in output can be obtained. *Do not touch the oscillator adjustment after it has been set in (8)*. Make the final adjustment at 156 mc. by means of the trimmers.

(12) Set the THRESHOLD SENSITIVITY control so the meter will read 5 ma. with the R.F. GAIN INCREASE control full ON.

(13) Make a series of sensitivity measurements every 10 mc. beginning at 100 mc. The microvolt input at 10 to 1 signal-to-noise ratio should be less than 5 microvolts at any point, and measurements of input voltage for the same output voltage made 10 mc. apart should not ordinarily vary more than 1 microvolt. If the sensitivity varies more than 1 microvolt from one 10 mc. measurement to the next (for example between 100 to 110 mc.) check the placing of the hairpin coil from the doubler stage at 130 mc. as the relationship may have been changed, when the 100 mc. inductance adjustment was made, enough to cause the mutual coupling to be off at the frequencies where the lowered sensitivity shows up.

e. THRESHOLD SENSITIVITY CONTROL ADJUSTMENT.—After all alignments have been completed, the THRESHOLD SENSITIVITY control should be set. Turn off the signal generator but leave it connected to the receiver antenna connection, or ground the receiver antenna connection directly. Turn the R.F. GAIN INCREASE control to maximum gain position. Reduce the gain by turning the THRESHOLD SENSITIVITY control counterclockwise until the meter reads 5 milliamperes. Check power supply voltages before this adjustment is made. The tuning should now read approximately 5 ma.

35. ALIGNMENT USING TEST EQUIPMENT IE-19-A.

Signal Generator I-130-A (part of Test Equipment IE-19-A) can be used to align the radio frequency and high-frequency oscillator. No dummy antenna is required. The receiver is connected directly to the generator by means of the low-impedance, concentric Cord CD-477 which is part of the test equipment. Proceed with the alignment as in paragraph 34, section V.

Test Equipment IE-19-A cannot be used to properly align the intermediate frequency transformers and the beat-frequency oscillator. This alignment is best done with a Ferris 16C signal generator, but satisfactory results can be obtained with a Ferris 18B, 18C, or 18D or any signal generator which has a low impedance output and which can be accurately set to 11930 and 12070 kc (see paragraph 34, section V).

36. ALIGNMENT USING FREQUENCY METER BC-638-A.

Frequency Meter BC-638-A may be used to align the radio-frequency and high-frequency oscillator. The frequency-meter antenna must be left in place so that the signal can be transmitted to the receiver. The receiver antenna should be in place.

Proceed with alignment as in paragraph 34, section V. Use the crystals which provide signals near the specified alignment frequencies.

The intermediate frequency transformers and beat-frequency oscillator cannot be properly aligned with Frequency Meter BC-638-A.

37. OVERALL PERFORMANCE TESTS.

a. GENERAL.—If at any time the operation of Radio Receiver BC-639-A is questionable, measure its performance using the following procedure.

Make all repairs or adjustments, and check to insure that the adjustments have been properly made. These measurements should conform to the normal performance characteristics given in paragraph 37*b*.

b. STANDARD TEST CONDITIONS.

(1) INPUT POWER VOLTAGE.—200 to 250v a-c when used with Rectifier RA-42-A or Rectifier RA-42-B with supply voltage control set to proper input voltage.

5.5v to 6.3v d-c to dynamotor when used with Dynamotor Unit PE-100-A.

NOTE

When using Dynamotor Unit PE-100-A power supply, the filament supply voltage is slightly lower than that of Rectifier RA-42-A (or Rectifier RA-42-B). The plate voltage should remain about the same. The input voltage to Rectifier RA-42-A (or Rectifier RA-42-B) may be 100-125 volts alternating current provided the power transformer is properly connected and SUPPLY VOLTAGE CONTROL switch is set to the correct value. *See Instruction Book for Operation and Maintenance* of Rectifier RA-42-A and Rectifier RA-42-B.

(2) WARM-UP PERIOD.—Five minutes unless otherwise stated.

(3) ARTIFICIAL ANTENNA.—Electrical equivalent of 70-ohm line. (*If a Ferris Model 18D signal generator, which has an output impedance of approximately 14 ohms is used, a 50-ohm ±5 per cent, non-inductive resistor is placed in series with the "hot" side of generator output.*)

(4) STANDARD INPUT SIGNAL.—Obtained from Ferris Model 18B, 18C, 18D or 16C or any signal generator which has a low impedance output and which can be accurately set to 11930 and 12070 kc. modulated 30 per cent at 1000 cps.

(5) OUTPUT LOAD.—600 ohms (non-inductive).

(6) SIGNAL-TO-NOISE RATIO.—The standard signal-to-noise ratio is 10 to 1 for 10 mw output. To obtain 10 to 1 signal-to-noise ratio the R.F. GAIN INCREASE control and signal input voltage are adjusted at the same time until the power output, with modulation on (signal modulated by 1000 cycles), is ten times the power output with carrier modulation OFF at 30% only. Since these sensitivity measurements are based on 10:1 signal-to-noise ratio with 10 mw output, there should be an output of 10 mw (2.45 volts across a 600-ohm resistor load) with modulated carrier and 1 mw (.775 volts across a 600-ohm resistor load) with unmodulated carrier. *On some generators, the carrier frequency may be shifted slightly by modulation, and it may be necessary to retune receiver when modulation is removed to come back on carrier or "noise".*

(7) R.F. GAIN INCREASE CONTROL.—Set at maximum, unless noise level reduction is necessary to obtain a 10:1 signal-to-noise ratio.

(8) AUDIO GAIN INCREASE CONTROL.—Set at maximum unless otherwise specified.

(9) C.W. AND MANUAL—MANUAL—A.V.C. SWITCH.—Set at MANUAL unless otherwise specified.

(10) ATTENUATION SWITCH.—Set at 0 DB.

(11) DUST COVER OF RECEIVER.—The dust cover shall be replaced for measurements made on overall performance; with signal fed into antenna post of receiver.

(12) ALIGNMENT OF RECEIVER.—Align all circuits of the receiver properly in accordance with the alignment procedure given in paragraph 34.

c. METHODS OF MEASUREMENT.—To make performance tests, each measurement should be made as described in the text below.

(1) INTERMEDIATE FREQUENCY SENSITIVITY AND SELECTIVITY.

(*a*) Connect the signal generator directly to the grid of the mixer tube. Modulate a 12 mc. carrier to 30 per cent at 1000 cps.

(*b*) Connect the output of the receiver to a standard non-inductive load of 600 ohms.

(*c*) Adjust the output of the signal generator and adjust the R.F. GAIN INCREASE control for a 10 to 1 signal-to-noise ratio with 10 mw output. Record this sensitivity. The signal input should be less than 15 μv.

(*d*) Increase the input 2 times, or 6 db, and adjust the signal generator above and below resonance to the frequencies required to produce 10 mw output, leaving the R.F. GAIN INCREASE control unchanged. Compute the total band-width.

(*e*) Repeat step (d) above for input voltage ratios of 100 times (40 db) and 1000 times (60 db.) The results should conform as follows:

Ratio	*Limit*
X2	More than 130 kc
X100	Less than 350 kc
X1000	Less than 450 kc

Accurate values cannot be obtained in this test with a Ferris Signal Generator Model 18C or 18D. Model 16C is recommended for accurate measurements. However, the band-width will conform with values in above table *if* receiver is properly aligned.

(2) FIDELITY.

(*a*) Connect the signal generator directly to grid of the mixer tube.

(*b*) Connect an audio-frequency generator to the external modulation terminals of the signal generator so that signal of latter may be modulated 30 per cent at any audio frequency from 200 to 5,000 cps.

(*c*) With a 12-mc carrier modulated 30 per cent at 1000 cps, adjust the output of the signal generator and adjust the R.F. GAIN INCREASE control for 10 to 1 signal-to-noise ratio with 10 mw output. This is the normal intermediate frequency sensitivity.

(*d*) Reduce gain for 1/10 normal sensitivity; that is, increase signal input voltage to 10 times the normal sensitivity value and decrease the R.F. GAIN INCREASE control to maintain 10 mw output. Increase input to give 50 mw output.

(*e*) The audio response should be flat (+2 −6db) from 600 to 2500 cps inclusive. The signal should be attenuated at least 10 db at 200 cps and 5000 cps, referred to 50 mw at 1000 cps as the reference level.

(3) OUTPUT REGULATION.

(*a*) Connect the signal generator directly to the grid of the mixer tube. Modulate a 12-mc carrier 30 per cent at 1000 cps.

(*b*) Adjust the signal generator output and the R.F. GAIN INCREASE control for 10 to 1 signal-to-noise ratio at 10 mw output. This is the normal intermediate frequency sensitivity.

(*c*) Increase the signal input voltage to 10 times the normal sensitivity value and decrease the R.F. GAIN INCREASE control to maintain 10 mw output. Increase the signal input to produce 50 mw output.

(*d*) Leaving above conditions unchanged, vary the load impedance between 200 ohms and 20,000 ohms, and record the output power level in db referred to 50 mw into 600 ohms load at 0 DB.

(*e*) The output regulation is such that the output will not change more than +6 db to −6 db with an output impedance change of from 200 ohms to 20,000 ohms at 1000 cps, referred to the 600-ohm reference level.

(4) NORMAL RADIO FREQUENCY SENSITIVITY.

(*a*) Connect the signal generator to the antenna of the receiver through the proper dummy antenna [see Paragraph 37*b* (3)]. Modulate the carrier 30 per cent at 1000 cps. Connect the output of the receiver to a 600-ohm non-inductive load.

(*b*) At each test frequency between 100 and 156 mc adjust the signal generator output and R.F. GAIN INCREASE control for 10 to 1 signal-to-noise ratio with 10 mw total output. Record signal-to-noise ratio if 10 to 1 cannot be obtained.

(*c*) Between frequencies of 100 mc and 156 mc, the sensitivity should be better than 5 μv for 10 to 1 signal-to-noise ratio, 10 mw output.

(5) INPUT AS COMPARED WITH OUTPUT.—At no point up to 100,000 μv input should the output drop below 500 mw for 1000 cps modulation. This requirement should also be met on C.W. operation. On A.V.C. the output should increase with increasing input up to 1,000 μv. *It may be necessary to retune the receiver for the different inputs because the signal generator is sometimes detuned by its attenuator.*

(6) IMAGE FREQUENCY REJECTION.

(*a*) Connect the signal generator to the antenna of the receiver through the proper dummy antenna [see Paragraph 37*b* (3)]. Modulate the carrier 30 per cent at 1000 cps. Connect output of receiver to 600-ohm non-inductive load.

(*b*) At each test frequency between 100 to 156 mc, adjust the signal generator output and R.F.

GAIN INCREASE control for 10 to 1 signal-to-noise ratio with 10 mw total output. Record signal-to-noise ratio if 10 to 1 cannot be obtained.

(*c*) Adjust the signal generator frequency to the image frequency (signal frequency less twice the intermediate frequency) and record the input in μv necessary to produce 10 mw output.

(*d*) The image rejection ratio is the ratio of the input at the image frequency to the input at the signal frequency required to produce a 10 mw output.

(*e*) For test frequencies between 100 and 156 mc, the ratio should be greater than 3000 to 1 or approximately 70 db.

(7) INTERMEDIATE FREQUENCY REJECTION.

(*a*) Connect the signal generator to the antenna of the receiver through the proper dummy antenna [see Paragraph 37*b* (3)]. Modulate the carrier 30 per cent at 1000 cps. Connect the output circuit of the receiver to a 600-ohm non-inductive load.

(*b*) At each test frequency between 100 and 156 mc, adjust the signal generator output and R.F. GAIN INCREASE control for 10 to 1 signal-to-noise ratio with 10 mw total output. Record signal-to-noise ratio if 10 to 1 cannot be obtained.

(*c*) Change input frequency to intermediate frequency (12mc) and record input in μv necessary to produce 10 mw output.

(*d*) The intermediate frequency rejection ratio is the ratio of the input at the intermediate frequency to the input at the signal frequency to give 10 mw output. *DO NOT SELECT TEST FREQUENCIES WHICH ARE AT OR NEAR HARMONICS OF INTERMEDIATE FREQUENCY.*

(*e*) For test frequencies between 100 and 156 mc, the ratio should be greater than 20,000 to 1 or about 86 db.

(8) UNDESIRED RESPONSES.

(*a*) Connect the signal generator to the antenna of the receiver through the proper dummy antenna [see Paragraph 37*b* (3)]. Modulate the carrier 30 per cent at 1000 cps. Connect the output of the receiver to a 600-ohm non-inductive load.

(*b*) At each test frequency between 100 and 156 mc, adjust the signal generator output and R.F. GAIN INCREASE control for 10 to 1 signal-to-noise ratio with 10 mw total output. Record signal-to-noise ratio if 10 to 1 cannot be obtained.

(*c*) Vary the signal generator frequency from 100 mc to 160 mc and record the frequency of all responses which are heard. For each response heard record the μv input necessary to produce 10 mw output.

(*d*) The undesired response-rejection ratio is the ratio of the signal input at the undesired response frequency to the signal input at the desired signal frequency to give 10 mw output. (*Image frequencies and generator harmonics excepted.*)

(*e*) Specification requires that this ratio be greater than 10,000 to 1 or 80 db. NOTE: *There should be no beat frequency oscillator harmonics present (harmonics of 6 mc) with the receiver at CW.*

(9) TUNING METER.

(*a*) Connect the signal generator to the antenna of the receiver through the proper dummy antenna [See section V, paragraph 37*b* (3)]. Turn modulation OFF. Connect the output circuit of receiver to 600-ohm non-inductive load.

(*b*) Set C.W. AND MANUAL—MANUAL—A.V.C. switch at A.V.C.

(*c*) Check the position of THRESHOLD SENSITIVITY control. It must be set for proper no-signal-noise level (5-10 mw with antenna terminal grounded).

(*d*) The meter should read about 5 ma with no signal input, provided voltages are normal. Vary the signal input voltage and determine that the results obtained conform to the following;

Input (μv)	*Meter Reading (ma)*	*Change in ma*
0	5.0 approx.	0
10	5.0 approx.	0
100	4.8 approx.	> .2
1,000	3.2 approx.	> 1.8
10,000	2.0 approx.	> 3.0
100,000	1.2 approx.	> 3.8

(10) CALIBRATION ACCURACY.—Between dial settings of 100 and 156 mc, the calibration accuracy should be better than ±1 mc. The end points of 100 mc and 156 mc can be made exact by properly adjusting the inductance and capacity of the high frequency oscillator circuit.

38. OUTPUT POWER MEASUREMENTS.

If you can not get an audio power output meter, audio output measurements may be made by connecting a 600-ohm non-inductive resistor across the Ballantine Electronic Voltmeter Model 300 or any alternating current voltmeter with 1000-Ω per volt sensitivity or higher and which will measure up to 25v and parallel this combination across the receiver audio output. For a 600-ohm load, the voltmeter readings are converted to milliwatts by the expression:

$$E = .775 \sqrt{P}$$
or
$$P = 1.67 E^2$$

Where E = Volts
and P = Milliwatts

The output power values mentioned in this book are as follows.

E (volts)	*P (milliwatts)*
.775	1
1.78	5
2.45	10
5.48	50
17.3	500
24.5	1000

39. REPLACING DEFECTIVE COMPONENTS.

When a component is found to be defective replace it with an identical component from the spare parts provided. Check with the data in the Table of Replaceable Parts (section VII, paragraph 44), to be sure that the component is properly identified. The new part must comply in every particular with the data contained therein.

a. Before removing a part from the unit, make a careful note of the leads connected to it and unsolder them. Bend the wires only as much as is necessary to remove the component. *Apply the*

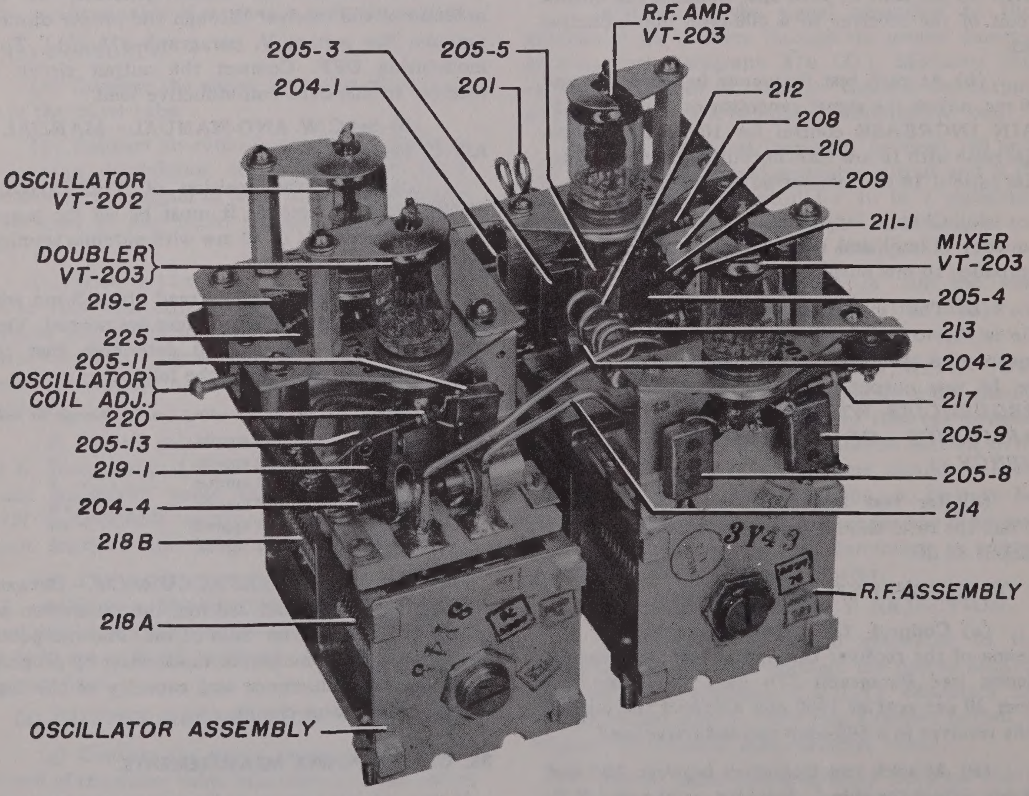

R.F. AMP.
VT-203
205-3
205-5
204-1
201
212
208
210
209
211-1
MIXER
VT-203
OSCILLATOR
VT-202
DOUBLER
VT-203
219-2
225
205-11
OSCILLATOR
COIL ADJ.
220
205-13
219-1
204-4
218 B
218 A
205-4
213
204-2
217
205-9
205-8
214
3Y43
R.F. ASSEMBLY
OSCILLATOR ASSEMBLY

Figure 20 — Radio Receiver BC-639-A, Top Rear Oblique, R. F. and Oscillator Assembly

soldering iron just long enough to soften the soldered joint. Lengthy application of the soldering iron may loosen the terminal or other soldered joints on adjacent components.

b. Components can be removed with a screwdriver, pliers and soldering iron. Washers are provided with all screws. *Always replace the washer between the head of the screw and the face of the panel or chassis.*

c. When you put in new parts, use the same screws used for the old part whenever they are in good condition. *Be careful in tightening the screws not to strip the threads.*

d. Use only rosin core solder or special flux intended for radio use. *NEVER USE PASTE OR ACID FLUX.*

e. Clean and tin *both* terminal and wire before attempting to make a connection. Fasten the wire mechanically by twisting it around the terminal and clipping the surplus before soldering. Heat the wire and terminal so the solder will flow into the joint. *AFTER SOLDERING, DO NOT DISTURB JOINT UNTIL IT COOLS.* Remove any excess solder so that it will not cause future short circuits and grounds.

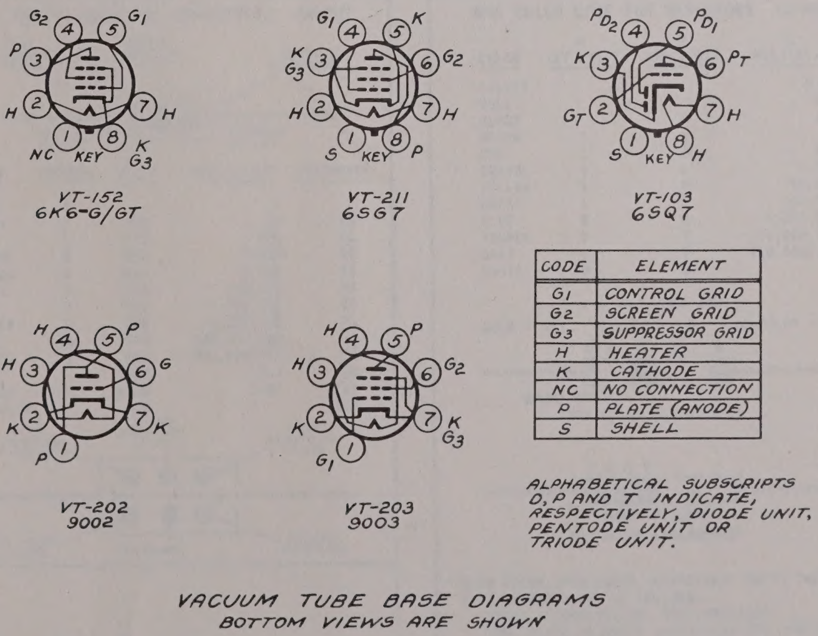
f. Maintenance of switches and relays should not be attempted in the field. All repairs of this unit must be made only by trained personnel equipped with specific maintenance instructions, test equipment, and tools for this purpose.

If the unit fails to operate properly, notify the maintenance depot and do not attempt to use the unit until it is repaired.

40. VACUUM TUBE REPLACEMENT.

a. When a tube fails, replace it. *If several tubes fail, it will be best to have the receiver realigned by competent personnel in a properly equipped laboratory or service shop. If complete facilities for realigning the receiver are not available do not attempt realignment as satisfactory operation can still be had.*

b. When replacing the oscillator Tube VT-202 in the receiver, it may be necessary to retune the oscillator stage to have the tuning dial indicate exact frequency. *THIS ADJUSTMENT MAY BE DONE AND IS THE ONLY INTERNAL ADJUSTMENT PERMITTED TO BE MADE ON THE RECEIVER BY THE STATION OPERATOR.*



CODE	ELEMENT
G1	CONTROL GRID
G2	SCREEN GRID
G3	SUPPRESSOR GRID
H	HEATER
K	CATHODE
NC	NO CONNECTION
P	PLATE (ANODE)
S	SHELL

ALPHABETICAL SUBSCRIPTS D, P AND T INDICATE, RESPECTIVELY, DIODE UNIT, PENTODE UNIT OR TRIODE UNIT.

Figure 21 — Radio Receiver BC-639-A, Vacuum Tube Base

The procedure is as follows:

(1) Replace the oscillator Tube VT-202. There is only one VT-202 in the receiver; so the proper tube to replace cannot be mistaken.

(2) Tune the receiver to a signal from the frequency meter as close to 156 megacycles, the high end of the band, as possible. Set the dial to read the exact frequency of the incoming signal even though this setting detunes the receiver.

(3) Adjust the trimmer capacitor screw 204-5, (below the oscillator tube) for maximum volume of the signal at this dial setting. *THERE ARE TWO SCREWS BELOW THE OSCILLATOR TUBE. SEE FIG. 15, TO PREVENT MAKING THE WRONG ADJUSTMENT. NEVER ADJUST THE UPPER SCREW.*

NOTE

Use a signal from the frequency meter for the adjustment. The signal must not be too strong, however.

41. PILOT BULB REPLACEMENT.

a. Remove the fifteen round-head screws, including the three screws around the antenna terminal, holding the dust cover on the chassis and remove the dust cover.

b. Remove the burned out bulb by hand. It is a bayonet base bulb and is merely twisted in the socket and removed.

c. Replace with a new 6-8 volt, 0.25 ampere bayonet base bulb, Mazda #44.

d. Replace the dust cover and tighten the fifteen round-head screws, including the three screws around the antenna terminal.

SECTION VII
TABLE OF REPLACEABLE PARTS

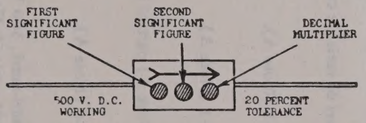
ORDERING OF SPARE PARTS

Each Service using this list has established certain depots and service groups for the storage and issue of spare parts to its organizations requiring them. The regulations of each Service should be studied to determine the method and source for requisitioning spare parts. The information in this list, as to manufacturer's or contractor's name, type, model or drawing number, is not to be interpreted as authorization to field agencies to attempt to purchase identical or comparable spare parts direct from the manufacturer or a wholesale or retail store except under emergency conditions as covered by existing regulations of the Service concerned.

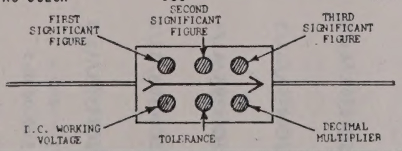
U. S. ARMY PERSONNEL: This table is for information *ONLY* and is not to be used as a basis for requisitioning parts. Authorities for obtaining maintenance items are as follows: For using organizations, applicable service publications of the 00-30 series of Army Air Forces Technical Orders; for higher maintenance and supply echelons, the applicable Standard Maintenance List, or applicable service publications of the 08-55 series of Army Air Forces Technical Orders.

RMA COLOR CODES

RMA COLOR CODES FOR CAPACITORS (MMFD)


FIRST SIGNIFICANT FIGURE
SECOND SIGNIFICANT FIGURE
DECIMAL MULTIPLIER
500 V. D.C. WORKING
20 PERCENT TOLERANCE

COLOR	NUMERAL	VOLTS	MULTIPLIER	TOLERANCE
BLACK	0		1	
BROWN	1	100	10	1%
RED	2	200	100	2%
ORANGE	3	300	1,000	3%
YELLOW	4	400	10,000	4%
GREEN	5	500	100,000	5%
BLUE	6	600	1,000,000	6%
VIOLET	7	700	10,000.000	7%
GRAY	8	800	100,000,000	8%
WHITE	9	900	1,000,000,000	9%
GOLD		1000	0.1	5%
SILVER		2000	0.01	10%
NO COLOR		500		20%

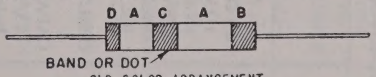

FIRST SIGNIFICANT FIGURE
SECOND SIGNIFICANT FIGURE
THIRD SIGNIFICANT FIGURE
D.C. WORKING VOLTAGE
TOLERANCE
DECIMAL MULTIPLIER

RMA COLOR CODE FOR RESISTORS (OHMS)

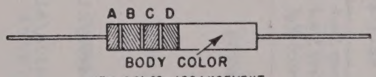
COLOR	A 1ST DIGIT	B 2ND DIGIT	C MULTIPLIER
SILVER			0.01
GOLD			0.1
BLACK		0	1.0
BROWN	1	1	10
RED	2	2	100
ORANGE	3	3	1,000
YELLOW	4	4	10,000
GREEN	5	5	100,000
BLUE	6	6	1,000,000
PURPLE	7	7	10,000,000
GRAY	8	8	100,000,000
WHITE	9	9	

D - TOLERANCE CODE:

GOLD = 5%   SILVER = 10%   NO COLOR = 20%


D A C A B
BAND OR DOT

OLD COLOR ARRANGEMENT


A B C D
BODY COLOR

NEW COLOR ARRANGEMENT

BODY COLOR (NEW COLOR ARRANGEMENT ONLY) INDICATES TYPE OF RESISTOR, AS FOLLOWS:-
- BLACK - COMPOSITION, NON-INSULATED
- TAN, OLIVE OR WHITE - COMPOSITION, INSULATED
- DARK BROWN - WIRE-WOUND, INSULATED

The procedure is as follows:

(1) Replace the oscillator Tube VT-202. There is only one VT-202 in the receiver; so the proper tube to replace cannot be mistaken.

(2) Tune the receiver to a signal from the frequency meter as close to 156 megacycles, the high end of the band, as possible. Set the dial to read the exact frequency of the incoming signal even though this setting detunes the receiver.

(3) Adjust the trimmer capacitor screw 204-5, (below the oscillator tube) for maximum volume of the signal at this dial setting. *THERE ARE TWO SCREWS BELOW THE OSCILLATOR TUBE. SEE FIG. 15, TO PREVENT MAKING THE WRONG ADJUSTMENT. NEVER ADJUST THE UPPER SCREW.*

NOTE

Use a signal from the frequency meter for the adjustment. The signal must not be too strong, however.

41. PILOT BULB REPLACEMENT.

a. Remove the fifteen round-head screws, including the three screws around the antenna terminal, holding the dust cover on the chassis and remove the dust cover.

b. Remove the burned out bulb by hand. It is a bayonet base bulb and is merely twisted in the socket and removed.

c. Replace with a new 6-8 volt, 0.25 ampere bayonet base bulb, Mazda #44.

d. Replace the dust cover and tighten the fifteen round-head screws, including the three screws around the antenna terminal.

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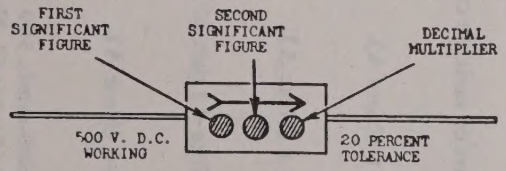
RMA COLOR CODES

RMA COLOR CODES FOR CAPACITORS (MMFD)


FIRST SIGNIFICANT FIGURE
SECOND SIGNIFICANT FIGURE
DECIMAL MULTIPLIER
500 V. D.C. WORKING
20 PERCENT TOLERANCE

COLOR	NUMERAL	VOLTS	MULTIPLIER	TOLERANCE
BLACK	0		1	
BROWN	1	100	10	1%
RED	2	200	100	2%
ORANGE	3	300	1,000	3%
YELLOW	4	400	10,000	4%
GREEN	5	500	100,000	5%
BLUE	6	600	1,000,000	6%
VIOLET	7	700	10,000.000	7%
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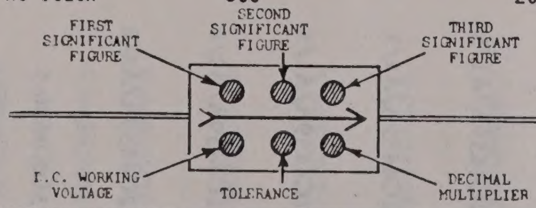
GOLD		1000	0.1	5%
SILVER		2000	0.01	10%
NO COLOR		500		20%

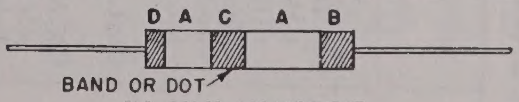

FIRST SIGNIFICANT FIGURE
SECOND SIGNIFICANT FIGURE
THIRD SIGNIFICANT FIGURE
I.C. WORKING VOLTAGE
TOLERANCE
DECIMAL MULTIPLIER

RMA COLOR CODE FOR RESISTORS (OHMS)

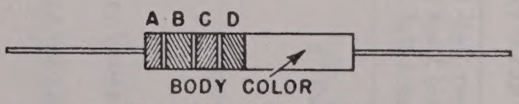
COLOR	A 1ST DIGIT	B 2ND DIGIT	C MULTIPLIER
SILVER			0.01
GOLD			0.1
BLACK		0	1.0
BROWN	1	1	10
RED	2	2	100
ORANGE	3	3	1,000
YELLOW	4	4	10,000
GREEN	5	5	100,000
BLUE	6	6	1,000,000
PURPLE	7	7	10,000,000
GRAY	8	8	100,000,000
WHITE	9	9	

D - TOLERANCE CODE:

GOLD = 5% SILVER = 10% NO COLOR = 20%


D A C A B
BAND OR DOT

OLD COLOR ARRANGEMENT


A B C D
BODY COLOR

NEW COLOR ARRANGEMENT

BODY COLOR (NEW COLOR ARRANGEMENT ONLY) INDICATES TYPE OF RESISTOR, AS FOLLOWS:-
BLACK - COMPOSITION, NON-INSULATED
TAN, OLIVE OR WHITE - COMPOSITION, INSULATED
DARK BROWN - WIRE-WOUND, INSULATED

SECTION VII

TABLE OF REPLACEABLE PARTS

MODEL: RADIO RECEIVER BC-639-A

Reference Symbol	*Army Stock No.* *Navy Stock No.* *British Ref. No.*	*Name of Part and Description*	*Function*	*Mfr. and Desig. or AWS Type*	*Cont. or Govt. Dwg. or Spec. No.*
200	2Z7097-3	PLATE INSULATING ASSEMBLY: Consists of plate, phenolic 1-13/32″ diameter, x 1/8″ thick, contact socket, 1 contact, overall dim. 1-27/64″ x 0.265″ O.D. x 0.248″ I.D.; spring clip, phosphor bronze 0.010″ gauge x 0.475″ long x 15/64″ I.D.; lock washer No. 1P split, phosphor bronze washer, plain No. 10 BR.; nut 10-32 hex, BR.	Antenna coupling	Bendix	C58585-1
201	2C4439A/A1/1	COIL: Antenna; 2 turns; No. 14 copper wire 5/16″ I.D.	Antenna coil	Bendix	A105064
202	2C4439A/A1/2	CAPACITOR: Variable; R-f tuning; 3 section air diaelectric; 4-23/32″ long x 2″ wide x 3-7/16″ high; 4 No. 4-40 tap mounting holes, 1 3/4″ apart center to center; include trimmers, ref. nos. 204-1 to 3.	R-f tuning	Bendix	L72799-2
203	3D9015-8	CAPACITOR: Fixed; 15 mmf. ±20%; Aerovox Type 1468, Cornell-Dubilier, Micamold—O or OXM, Sangamo Type K, Solar—MOFW or MDCW; 5-1/64″ x 15/32″ x 7/32″ maximum; 1 1/4″ No. 20 AWG tinned lead, low loss bakelite case. (Note B).	R-f grid coupling	Aerovox, C.D., Micamold, Sangamo, Solar	C58469-150
204-1	2C4439A/A1/3	CAPACITOR: Trimmer; (part of variable capacitor—202). (Note A).	R-f grid trimmer	Bendix	L72799-2
204-2	2C4439A/A1/3	CAPACITOR: Same as 204-1 (Note A).	R-f plate trimmer	Bendix	L72799-2
204-3	2C4439A/A1/3	CAPACITOR: Same as 204-1 (Note A).	Mixer grid trimmer	Bendix	L72799-2
204-4	2C4439A/A2/2	CAPACITOR: Trimmer; (Note A) part of Ref. No. 218.	Doubler plate trimmer	Bendix	L72798-2
204-5	2C4439A/A2/2	CAPACITOR: Same as 204-4 (Note A).	Osc. tank trimmer	Bendix	L72798-2
205-1	3DK9680-5	CAPACITOR: Fixed mica; 680-mmf., 500 Vdcw, ±20%; molded bakelite case 11/16″ x 7/16″ x 3/16″; No. 20 AWG tinned leads 1 1/4″ long, Aerovox 1468, Dubilier 5LS. (Note A).	R-f a-v-c filter	Aerovox, C.D.	C58469-681
205-2	3DK9680-5	Same as 205-1 (Note A).	R-f cathode bypass	Aerovox, C.D.	C58469-681

205-3	3DK9680-5	Same as 205-1 (Note A).	R-f heater bypass	Aerovox, C.D.	C58469-681
205-4	3DK9680-5	Same as 205-1 (Note A).	R-f plate to cathode bypass	Aerovox, C.D.	C58469-681
205-5	3DK9680-5	Same as 205-1 (Note A).	R-f screen bypass	Aerovox, C.D.	C58469-681
205-6	3DK9680-5	Same as 205-1 (Note A).	R-f plate to ground bypass	Aerovox, C.D.	C58469-681
205-7	3DK9680-5	Same as 205-1 (Note A).	Mixer cathode bypass	Aerovox, C.D.	C58469-681
205-8	3DK9680-5	Same as 205-1 (Note A).	Mixer heater bypass	Aerovox, C.D.	C58469-681
* 205-9	3DK9680-5	Same as 205-1 (Note A).	Mixer Screen bypass	Aerovox, C.D.	C58469-681
205-10	3DK9680-5	Same as 205-1 (Note A).	Doubler plate bypass	Aerovox, C.D.	C58469-681
205-11	3DK9680-5	Same as 205-1 (Note A).	Doubler Screen bypass	Aerovox, C.D.	C58469-681
205-12	3DK9680-5	Same as 205-1 (Note A).	Doubler cathode bypass	Aerovox, C.D.	C58469-681
205-13	3DK9680-5	Same as 205-1 (Note A).	Doubler heater bypass	Aerovox, C.D.	C58469-681
205-14	3DK9680-5	Same as 205-1 (Note A).	Osc. heater bypass	Aerovox, C.D.	C58469-681
206	3Z6700-71	RESISTOR: Fixed; carbon; 100,000 ohms, ±20%, ½ watt; ⅜" long x 9/64" dia., No. 20 leads 1½" long; Allen Bradley Type EB; Speer Type SI-½. (Note B).	R-f a-v-c filter	Allen-Bradley, Speer	A112927-104
207	3Z6756-5	RESISTOR: Fixed; composition; 560,000 ohms ±10%, ½ watt; ⅜" long x 9/64" dia.; No. 20 leads 1½" long; Allen-Bradley Type EB; Speer Type SI-½. (Note B).	R-f grid leak	Allen-Bradley, Speer	A32298-564
208	3Z6033-13	RESISTOR: Fixed; composition; 330 ohm, ±10%, ½ watt; ⅜" long x 5/32" dia.; No. 20 leads 1½" long; Allen-Bradley Type EB; I.R.C. BTS; Speer Type SI-½. (Note B).	R-f cathode bias	Allen-Bradley I.R.C., Speer	A32298-331

Note A.—Replace entire assembly in which this item is used.
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Reference Symbol	*Army Stock No. Navy Stock No. British Ref. No.*	*Name of Part and Description*	*Function*	*Mfr. and Desig. or AWS Type*	*Cont. or Govt. Dwg. or Spec. No.*
209	3Z6712-3	RESISTOR: Fixed; composition; 120,000 ohms ±10%, ½ watt; ⅜″ long x 5/32″ dia.; No. 20 leads 1½″ long; Allen-Bradley Type EB; Speer Type SI-½. (Note B).	R-f screen bleeder	Allen-Bradley, Speer	A32298-124
210	3ZK6639-15	RESISTOR: Fixed; composition; 39,000 ohms, ±10%; Allen-Bradley Type GB-1; 9/16″ long x 7/32″ dia., No. 18 leads 1½″ long. (Note B).	R-f screen dropping	Allen-Bradley	A112933-393
211-1	3Z6100-75	RESISTOR: Fixed; composition; 1000 ohms, ±20%; ½ watt; ⅜″ long x 9/64″ dia.; No. 20 tinned leads 1½″ long; Allen-Bradley Type EB; Speer Type SI-½. (Note B).	R-f plate dropping	Allen-Bradley, Speer	A112927-102
211-2		Same as 211-1.	Mixer cathode bias	Allen-Bradley, Speer	A32014-102
212	3C1074-8	COIL: Inductor; 2 turns No. 14 AWG (.064) soft drawn tinned copper wire. (Note A).	R-f plate coil	Bendix	A105065
213	3C1074-9	COIL: Inductor; 2 turns No. 14 AWG soft drawn tinned copper wire 9/32″ I.D. (Note A).	Mixer grid coil	Bendix	A105066
214	3C1074-10	COIL: 1 turn No. 12 B & S gauge .080 soft drawn tinned copper wire, ⅝″ I.D.; ends 19/32″ apart; 2-35/64″ long x 25/32″ width. (Note A).	Doubler plate coil	Bendix	A104311
215-1	3D9047-7	CAPACITOR: Fixed; silver mica; 47 mmf., ±20%, 500 VDCW; Aerovox Type 1468, Cornell Dubilier; Micamold, Sangamo and Solar; 11/16″ long x 7/16″ wide x 13/64″ thick; No. 20 AWG tinned leads 1¼″ long. (Note A).	Mixer grid coupling	Aerovox, C.D. Micamold, Sangamo, Solar	C58469-470
215-2	3D9047-7	Same as 215-1. (This is replaceable).	A-v-c diode coupling	Aerovox, C.D. Micamold, Sangamo, Solar	C58469-470
216	3Z6801A8	RESISTOR: Fixed; composition; 1.8 megohm ±10%; ⅜″ long x 5/32″ dia.; No. 20 leads 1½″ long; Allen-Bradley Type EB; Speer Type No. SI-½. (Note B).	Mixer grid leak	Allen-Bradley, Speer	A32298-185
217	3Z6727-9	RESISTOR: Fixed; composition; 270,000 ohms ±10%, ½ watt; ⅜″ long x 5/32″ dia.; No. 20 leads 1½″ long; Allen-Bradley Type EB; Speer Type No. SI-½. (Note B).	Mixer screen dropping	Allen-Bradley, Speer	A32298-274
218	2C4439A/A2/1	CAPACITOR: Variable; air dielectric; 2 sections, O-39.6 mmf. and O-36 mmf.; 100% rotation; 3-17/64″ long x 2″ wide x 3-7/16″ high, 4 mounting holes No. 4-40 tap, 1¾″ apart.	Osc. and doubler tuning	Bendix	L72798-2

219-1	3Z6470-14	RESISTOR: Fixed; composition; 4700 ohms ±20%, ½ watt; ⅜" long x 9/64" dia.; No. 20 AWG tinned copper leads 1½" long; Allen-Bradley Type EB; Speer Type No. SI-½. (Note B).	Doubler plate filter	Allen-Bradley, Speer	A112927-472
219-2	3Z6470-14	Same as 219-1. (Note B).	Osc. plate filter	Allen-Bradley, Speer	A112927-472
220	3Z6656-3	RESISTOR: Fixed; composition; 56,000 ohms ±10%, ½ watt; ⅜" long x 9/64" dia.; No. 20 leads 1½" long; Allen-Bradley Type EB; Speer Type No. SI-½. (Note B). (Alternate ASARC20-BF563I).	Doubler screen dropping	Allen-Bradley, Speer	A32298-563
221	3Z6056-2	RESISTOR: Fixed; composition; 560 ohms ±10%, ½ watt; ⅜" long x 9/64" dia.; No. 20 leads 1½" long; Allen-Bradley Type EB; Speer Type No. SI-½. (Note B). (Alternate ASARC205BF-561J).	Doubler cathode bias	Allen-Bradley, Speer	A32298-561
222	3Z6627-7	RESISTOR: Fixed; composition; 27,000 ohms ±10%, ½ watt; ⅜" long x 9/64" dia.; No. 20 leads 1½" long; Allen-Bradley Type EB; Speer Type No. SI-½. (Note B). (Alternate ASARC20BF 273K).	Doubler grid leak	Allen-Bradley, Speer	A32298-273
223	3C1074-11	COIL: Inductor; 7 turns No. 18 AWG .040 soft drawn tinned copper wire. (Note A).	H-f osc. coil	Bendix	A105061
224	3D9027-5	CAPACITOR: Fixed; mica, 27 mmf. ±20%; 500V dcw; Aerovox Type 1468; Cornell-Dubilier 5WST; Micamold O or OXM; Sangamo—K; Solar MOFW or MDCW; 11/16" long x 7/16" wide x 13/64" thick; 1½" leads No. 20 AWG tinned wire. (Note B). (Alternate 33 mmf. ±20%; 500 DCW; AWACM20B330M).	Doubler grid coupling	C.D., Aerovox Micamold, Sangamo, Solar	C58469-270
225	3DK9150-24	CAPACITOR: Fixed; mica; 150 mmf. ±20%; 500V dcw; Aerovox Type 1468; 11/16" long x 7/16" wide x 13/64" thick; 1¼" leads No. 20 AWG tinned. (Note B). (Alternate CM20B151M).	Osc. plate bypass	C.D., Aerovox	C58469-151
226	3Z6647-26	RESISTOR: Fixed; composition; 47,000 ohms ±20%, ½ watt; ⅜" long x 9/64" dia.; No. 20 leads 1½" long; Allen-Bradley Type EB; Speer Type No. SI-½. (Note B). (Alternate ASARC20BF-473M).	Osc. grid leak	Allen-Bradley, Speer	A112927-473
227-1	3D9015-9	CAPACITOR: Fixed; 15 mmf; ±5%; 500V. d.c.w.; Erie Type N750-K; modified.	1st i-f pri. tuning temp. comp.	Erie	A25715-15
227-2	3D9015-9	Same as 227-1.	1st i-f sec. tuning temp. comp.	Erie	A25715-15

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Reference Symbol	*Army Stock No. Navy Stock No. British Ref. No.*	*Name of Part and Description*	*Function*	*Mfr. and Desig. or AWS Type*	*Cont. or Govt. Dwg. or Spec. No.*
227-3	3D9015-9	Same as 227-1.	2nd i-f pri. tuning temp. comp.	Erie	A25715-15
227-4	3D9015-9	Same as 227-1.	2nd i-f sec. tuning temp. comp.	Erie	A25715-15
227-5	3D9015-9	Same as 227-1.	3rd i-f pri. tuning temp. comp.	Erie	A25715-15
227-6	3D9015-9	Same as 227-1.	3rd i-f sec. tuning temp. comp.	Erie	A25715-15
227-7	3D9015-9	Same as 227-1.	4th i-f pri. tuning temp. comp.	Erie	A25715-15
227-8	3D9015-9	Same as 227-1.	4th i-f sec. tuning temp. comp.	Erie	A25715-15
228-1	3D9060-1	CAPACITOR: Fixed; mica; 60 mmf.; ±2%; 500V d.c.w.; 1000 v.d. c.t.; 11/16" long x 7/16" high x 3/16" wide; No. 20 AWG leads 1¼" long; Aerovox Type 1469, Dubilier 5R.	1st i-f pri. tuning	Aerovox, C.D.	C58495-600
228-2	3D9060-1	Same as 228-1.	1st i-f sec. tuning	Aerovox, C.D.	C58495-600
228-3	3D9060-1	Same as 228-1.	2nd i-f pri. tuning	Aerovox, C.D.	C58495-600
228-4	3D9060-1	Same as 228-1.	2nd i-f sec. tuning	Aerovox, C.D.	C58469-600
228-5	3D9060-1	Same as 228-1.	3rd i-f pri. tuning	Aerovox, C.D.	C58469-600
228-6	3D9060-1	Same as 228-1.	3rd i-f sec. tuning	Aerovox, C.D.	C58469-600
228-7	3D9060-1	Same as 228-1.	4th i-f pri. tuning	Aerovox, C.D.	C58469-600

228-8	3D9060-1	Same as 228-1.	4th i-f sec. tuning	Aerovox, C.D.	C58469-600
229-1	3C610	INDUCTOR: 10 turns No. 22 enameled wire; primary coil of assembly 231. (Note B).	Mixer plate coil	Bendix	A104206-1
229-2	3C610	SECONDARY COIL OF ASSEMBLY 231: Same as 229-1. (Note B).	1st i-f grid coil	Bendix	A104206-1
229-3	3C610	PRIMARY COIL OF ASSEMBLY 232: Same as 229-1. (Note B).	1st i-f plate coil	Bendix	A104206-1
229-4	3C610	SECONDARY COIL OF ASSEMBLY 232: Same as 229-1. (Note B).	2nd i-f grid coil	Bendix	A104206-1
229-5	3C610	PRIMARY COIL OF ASSEMBLY 233: Same as 229-1. (Note B).	2nd i-f plate coil	Bendix	A104206-1
229-6	3C610	SECONDARY COIL OF ASSEMBLY 233: Same as 229-1. (Note B).	3rd i-f grid coil	Bendix	A104206-1
229-7	3C610	PRIMARY COIL OF ASSEMBLY 234: Same as 229-1. (Note B).	3rd i-f plate coil	Bendix	A104206-1
229-8	3C610	SECONDARY COIL OF ASSEMBLY 234: Same as 229-1. (Note B).	2nd det. diode coil	Bendix	A104206-1
230-1	3K3562222	CAPACITOR: Molded mica dielectric type; 6200 MMF; ± 5%; 500V dcw; CM35B622J; A.F. 3330-376154600.	Mixer plate bypass		
230-2	3K3562222	Same as 230-1.	H-V filter		
230-3	3K3562222	Same as 230-1.	1st i-f a-v-o filter		
230-4	3K3562222	Same as 230-1.	1st i-f cathode bypass		
230-5	3K3562222	Same as 230-1.	1st i-f screen bypass		
230-6	3K3562222	Same as 230-1.	1st i-f plate bypass		
230-7	3K3562222	Same as 230-1.	2nd i-f a-v-c filter		

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Reference Symbol	Army Stock No. Navy Stock No. British Ref. No.	Name of Part and Description	Function	Mfr. and Desig. or AWS Type	Cont. or Govt. Dwg. or Spec. No.
230-8	3K3562222	Same as 230-1.	2nd i-f cathode bypass		
230-9	3K3562222	Same as 230-1.	2nd i-f screen bypass		
230-10	3K3562222	Same as 230-1.	2nd i-f plate bypass		
230-11	3K3562222	Same as 230-1.	3rd i-f grid bypass		
230-12	3K3562222	Same as 230-1.	3rd i-f cathode bypass		
230-13	3K3562222	Same as 230-1.	3rd i-f heater bypass		
230-14	3K3562222	Same as 230-1.	3rd i-f screen bypass		
230-15	3K3562222	Same as 230-1.	3rd i-f plate bypass		
230-16	3K3562222	Same as 230-1.	A-v-c bus filter		
230-17	3K3562222	Same as 230-1.	1st a-f grid coupling		
230-18	3K3562222	Same as 230-1.	2nd a-f grid coupling		
230-19	3K3562222	Same as 230-1.	CW osc. plate bypass		
230-20	3K3562222	Same as 230-1.	CW osc. screen (anode) bypass		
230-21	3K3562222	Same as 230-1.	1st i-f cathode bypass		
230-22	3K3562222	Same as 230-1.	2nd i-f cathode bypass		

230-23	3K3562222	Same as 230-1.	3rd i-f cathode bypass		
230-24	3K3562222	Same as 230-1.	CW osc. heater bypass		
231	2Z10001.2	TRANSFORMER: 1st I.F. Assy.; 12 mc.; permeability tuned, adjustable iron core; includes 5 capacitors; metal can 3⅝″ x 2″ x 1-17/32″; 4 sub-chassis solder lug terminals; 2 flexible leads from side, mounted upright; mounting centers 1⅞″; transformer over-coupled to provide double hump 30 kc apart; includes 229-1, 229-2, 227-1, 227-2, 228-1, 228-2, 230-1.	1st i-f assembly	Bendix	L73530-1
232	2Z10001.11	TRANSFORMER: 2nd I.F. Assy.; 12 mc.; permeability tuned, adjustable iron core; includes 4 capacitors; metal can 3⅝″ x 2″ x 1-11/32″; 4 sub-chassis solder lug terminals mounted upright; mounting centers 1⅞″. Transformer over-coupled to provide double hump 30 kc apart; includes 229-3, 229-4, 227-3, 227-4, 228-3, 228-4.	2nd i-f assembly	Bendix	L73531-1
233	2Z10001.5	TRANSFORMER: 3rd I.F. Assy.; 12 mc.; permeability tuned two adjustments, one for the primary and one for the secondary; mounted in an aluminum can 1½″ x 2″ x 3-11/16″ which mounts by two threaded studs on the bottom of the case on 1⅞″ centers; 4 solder lug terminals on the bottom of unit. Transformer designed for optimum coupling with single peak response at 12 mc.; includes 229-5, 229-6, 227-5, 227-6, 228-5, 228-6.	3rd i-f assembly	Bendix	L73026-4
234	2Z10001.8	TRANSFORMER: 4th I.F. Assy.; 12 mc.; permeability tuned, 2 adjustments, one for primary and one for secondary; mounted in an aluminum can 1½″ x 2″ x 3-11/16″ which is mounted upright; mounting centers 1⅞″; 4 solder lug terminals on bottom of unit; transformer designed for peak response at 12 mc. with internal connections to the coil windings, so arranged to give reversal of the polarity between the primary and secondary, altering the resonant curve; includes 229-7, 229-8, 227-7, 227-8, 228-7, 228-8.	4th i-f assembly	Bendix	L73028-2
235-1	3Z6100-121	RESISTOR: Fixed; composition; 1000 ohm ±20%, 1 watt; 9/16″ long x 7/32″ dia.; No. 18 tinned copper leads 1½″ long; Allen-Bradley Type GB. (Alternate ASARC20BF102M).	Mixer plate filter	Allen-Bradley	A112931-102
235-2	3Z6100-121	Same as 235-1.	1st i-f plate filter	Allen-Bradley	A112931-102
235-3	3Z6100-121	Same as 235-1.	2nd i-f plate filter	Allen-Bradley	A112931-102

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Reference Symbol	Army Stock No. Navy Stock No. British Ref. No.	Name of Part and Description	Function	Mfr. and Desig. or AWS Type	Cont. or Govt. Dwg. or Spec. No.
235-4	3Z6100-121	Same as 235-1.	3rd i-f plate filter	Allen-Bradley	A112931-102
236-1	3Z6700-74	RESISTOR: Fixed; composition; 100,000 ohms ±20%, 1 watt; 9/16″ long x 7/32″ dia.; No. 18 tinned copper leads 1½″ long; Allen-Bradley Type GB No. 1042. (Alternate ASARC20BF104M).	1st i-f a-v-c filter	Allen-Bradley	A112931-104
236-2	3Z6700-74	Same as 236-1.	2nd i-f a-v-c filter	Allen-Bradley	A112931-104
236-3	3Z6700-74	Same as 236-1.	3rd i-f grid leak	Allen-Bradley	A112931-104
236-4	3Z6700-74	RESISTOR: Fixed; composition; 100,000 ohms ±10%, 1 watt; Bakelite insulation; 9/16″ long x 7/32″ dia.; No. 18 leads 1½″ long; Allen-Bradley Type GB.	A-f diode load	Allen-Bradley	A112933-104
236-5	3Z6700-74	Same as 236-4.	A-f diode load	Allen-Bradley	A112933-104
237-1	3RC20AE22/J	RESISTOR: Fixed; composition; 220 ohms ±5%; 1 watt; 9/16″ long x 7/32″ dia., leads No. 18 wire 1½″ long; Allen-Bradley Type GB-2211. (Alternate RC20BF221M).	1st i-f cathode bias	Allen-Bradley	A112933-221
237-2	3RC20AE22/J	Same as 237-1.	2nd i-f cathode bias	Allen-Bradley	A112933-221
237-3	3RC20AE22/J	Same as 237-1.	3rd i-f cathode bias	Allen-Bradley	A112933-221
237-4	3Z6022-25	RESISTOR: Fixed; carbon; 220 ohms, ±20%, 1 watt; 9/16″ long x 7/32″ dia., No. 18 leads 1½″ long. Allen-Bradley Type GB.	CW osc. grid parasitic suppressor	Allen-Bradley	A112931-221
238-1	3Z6647-19	RESISTOR: Fixed; composition; 47,000 ohms ±10%, 1 watt; Bakelite insulated; 9/16″ long x 7/32″ dia., No. 18 leads 1½″ long. Allen-Bradley Type GB. (Alternate ASARC20BF473M).	1st i-f screen dropping	Allen-Bradley	A112933-473
238-2	3Z6647-19	Same as 238-1.	2nd i-f screen dropping	Allen-Bradley	A112933-473
238-3	3Z6647-19	Same as 238-1.	3rd i-f screen dropping	Allen-Bradley	A112933-473
238-4	3Z6647-19	Same as 238-1.	CW osc. grid leak	Allen-Bradley	A112933-473

239-1	3DB1.484	CAPACITOR: Fixed; paper; oil; 1 mfd. 10%, 100 v.d.c.w.; metal case; 1-13/16″ long x 1″ wide, overall length 2½″; 2 insulated terminals; 2-3/16″ dia. mounting holes 2⅛″ centers.	Sens. control bus bypass	Aerovox	A104484
239-2	3DB1.484	Same as 239-1.	2nd audio cathode bypass	Aerovox	A104484
240	3F901-5	METER: 0-10 milliamperes; D.C.; Weston Model 506 (3) ⅛″ holes, mounting 1-5/32″ from center of meter 2½″ flush; GE Model DW 51, Westinghouse Model MX.	TUNING METER	Weston, Westinghouse, G.E.	A104194-4
241	2Z7262-3	POTENTIOMETER: "THRESHOLD SENSITIVITY"; 300 ohm, ±20% linear taper; Allen-Bradley Type "J" Bradleyometer; 1-1/16″ dia. 9/16″ deep; .25″ dia. shaft, ⅛″ long; screw adj.; no flat on shaft; ⅜″-32 thread mounting ¼″ long.	THRESHOLD SENSITIVITY control	Allen-Bradley	A105022
242	2Z7262-3M	POTENTIOMETER: Sensitivity control; 3000 ohms ±20%; Allen-Bradley Type "J"; 1-1/16″ dia. x 9/16″ deep; .25″ dia. shaft ¾″ long; 3 contacts.	R-f gain control	Allen-Bradley	C58961
243	3Z9825-32	SWITCH: 3 position; 5 contact; "C.W. MANUAL—AVC"; shorting type; ¼″ shaft x .25″ dia. x ¾″ long.	Selector switch	Mallory	C58583
244-1	3Z6801-43	RESISTOR: Fixed; composition; 1 megohm ±20%, ½ watt; No. 1052; ⅜″ long x 9/64″ dia.; No. 20 AWG leads 1½″ long. Allen-Bradley Type EB. Speer Type No. SI-½. (Alternate ASARC20-BF105M).	A-v-c diode load	Allen-Bradley, Speer	A112927-105
244-2	3Z6801-43	Same as 244-1.	A-v-c bus filter	Allen-Bradley, Speer	A112927-105
245-1	3D9330-4	CAPACITOR: Fixed; mica; 330 mmf. ±20%, 500 v.d.c.w., 1000 v.d.c.t.; 11/16″ long x 7/16″ wide x 13/64″ thick; No. 20 AWG leads 1¼″ long, Aerovox Type 1468ST; C.D. Type 5WST or 5WLST, Micamold Type O or OXM, Sangamo Type K, Solar Type MOFW or MOCW. (Alternate ASACM20B331N).	A-f diode load filter	C.D., Aerovox, Micamold, Sangamo, Solar	C58469-331
245-2	3D9330-4	Same as 245-1.	1st audio plate r-f bypass	C.D., Aerovox, Micamold, Sangamo, Solar	C58469-331
246	3D9001E8	CAPACITOR: Fixed; mica; 1.8 mmf. ±50%, 500 v.d.c.t.; Aerovox Type 1468, 11/16″ long x 3/16″ deep x 7/16″ wide, 1¼″ leads.	CW osc. coupling	Aerovox	C56336-18

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MODEL: RADIO RECEIVER BC-639-A

Reference Symbol	Army Stock No. Navy Stock No. British Ref. No.	Name of Part and Description	Function	Mfr. and Desig. or AWS Type	Cont. or Govt. Dwg. or Spec. No.
247	3D9220-1	CAPACITOR: Fixed; mica; 220 mmf. ± 20%, 500 d.c.w., 1000 v.d.c.t.; 11/16" long x 7/16" wide x 13/64" thick, No. 20 AWG leads 1-1/4" long, Aerovox 1468ST or 1468 LST, Micamold Type O or OXM, Sangamo Type K, Solar Type MOFW or MOCW. (Alternate ASACM20B2211Z).	A-f diode load filter	Aerovox, C.D., Micamold, Sangamo, Solar	C58469-221
248	3DA100-124	CAPACITOR: Fixed; paper; 0.1 mfd. ± 10%, 400 v.d.c.w.; moulded case, brown or black phenolic; Micamold or Solar; 1-29/64" long x 49/64" wide x 25/64" high. No. 18 leads 1-1/8" long.	1st audio cathode bypass	Micamold, Solar	A18015-104
249	3ZK6618-24	RESISTOR: Fixed; composition; 18,000 ohms ± 10%, 1 watt; Allen-Bradley Type GB; Bakelite insulation; 9/16" long x 7/32" dia. No. 18 AWG leads 1-1/2" long. (Alternate ASARC20BF-183J).	A-v-c-delay	Allen-Bradley	A112933-183
250	3RC20AE22J	RESISTOR: Fixed; composition; 2200 ohms ± 5%, 1 watt; Allen-Bradley Type GB; Bakelite insulated; 9/16" long x 7/32" dia. No. 18 AWG leads 1-1/2" long. (Alternate ASARC20BF222K).	1st audio bias	Allen-Bradley	A112933-222
251	2Z7262.1	POTENTIOMETER: Audio volume control; 1 megohm; Allen-Bradley Type "J" Bradleyometer Y-3986-D; 1-1/16" dia. x 9/16" deep, .25" dia. shaft; no switch; 3/4" long shaft 3/8-32 thread mounting.	Audio volume control	Allen-Bradley	A102616
252	3Z6568-5	RESISTOR: Fixed; composition; 68,000 ohms ± 10%, 1/2 watt; Allen-Bradley Type EB; Bakelite insulated; 3/8" long x 5/32" dia. No. 20 AWG leads 1-1/2" long. (Alternate ASARC20BF683J).	Audio attenuator	Allen-Bradley	A32298-683
253-1	3ZK6633-20	RESISTOR: Fixed; composition; 33,000 ohms ± 10%, 1/2 watt; Allen-Bradley Type EB; 3/8" long x 9/64" dia.; No. 20 AWG leads 1-1/2" long. (Alternate ASARC20BF33J).	Audio attenuator	Allen-Bradley	A32298-333
253-2	3ZK6633-20	Same as 253-1	Audio attenuator	Allen-Bradley	A32298-333
254	3Z9825-33	SWITCH: 3 position; 6 lugs shorting type; mounting bushing 3/4" long x 3/8"-32 thread, shaft 1/4" dia. x 1/2" long.	Attenuator switch	Mallory	C58584
255	3Z6733-8	RESISTOR: Fixed; carbon; 330,000 ohms ± 20%, 1 watt; Allen-Bradley Type GB; 9/16" long x 7/32" dia., No. 18 leads 1-1/2" long. (Alternate 330,000 ohms ± 20%, 1/2 watt; ASARC20BF).	2nd audio grid leak	Allen-Bradley	A112931-334
256	3RC41BE561J	RESISTOR: Fixed; carbon; 560 ohms ± 5%, 2 watt; JAN Type, No. RC41BE561J.	2nd Audio cathode bias	JAN	

257	3DA6.800	CAPACITOR: Fixed; paper; .0068 mfd. ±10%; 300 v.d.c.w.; moulded case; BM-120 Bakelite, wax impregnated; 600 v.d.c.t., 53/64″ long x 17/64″ wide x 53/64″ high, No. 20 AWG tinned leads, 1⅛″ long. (Alternate CM35B682K).	Output trans. tuning	Aerovox, Solar, C.D.	A25714-7
258	2Z10000-10	TRANSFORMER: Audio transformer; output level, 1 watt, ± 3DB for 300-3000 cycles, primary Z=12,500 ohms; Sec. Z=600 ohms; turns ratio P to S 4.56-1; Pri Res. 300 ohms, Sec. Res. 22 ohms, 1500 V.R.M.S. at 60 cycle test; 1⅞″ long x 1-7/16″ wide x 1⅞″ high; 5 terminals (4) No. 6-32 thread ¼″ deep spaced 1⅜″ and 1″ mounting holes.	Audio output	Bendix	A103058
259	2Z10000.1/1	COIL: (primary of transformer 2Z10000-10). (Note A).	Audio transformer primary	Bendix	A103058
260	2Z10000.1/2	COIL: (secondary of transformer 2Z10000-10). (Note A).	Audio transformer secondary	Bendix	A103058
261	3Z6470-15	RESISTOR: Fixed; composition; 4700 ohms ±20%, ½ watt; Allen-Bradley Type GB No. 4722; 9/16″ long x 7/32″ dia.; No. 18 tinned leads 1½″ long. (Alternate 4700 ohms; ±20%, ½ watt; ASARC20BF472M).	Output trans. center tap grounding	Allen-Bradley	A112931-472
262-1	2Z5542	JACK JK-42: Phone; tip, ring and sleeve contacts; same as West. Elec. Co. Type 239-A; 3-23/64″ long x 9/16″ dia., dia. plug hole .2515″ min. .253″ max.; 2 contacts open when plug is inserted.	Monitor jack	West. Electric	A103533
262-2	2Z5542	Same as 262-1.	Tel. line jack	West. Electric	A103533
263	2Z7228-14.1	PLUG: Jones Type P-406-AB-¾; 6 prong; No. 20 drill mounting hole 2.312″ apart.	Power cable plug	Jones	A105106
264	3Z6470-15	Same as 261. (Alternate 4700 ohms ±20%; 1 watt; ASARC30BF-472M).	CW osc. plate dropping	Allen-Bradley	A112931-472
265	3D9100-63	CAPACITOR: Fixed; silver mica; 100 mmf. ±10%; 500 v.d.c.w.; 11/16″ long x 7/16″ wide x 3/16″ thick, leads 1¼″ long, Aerovox Type 1469; C.D. Type 5R. (Alternate ASACM-20B101K).	CW osc. plate tuning	Aerovox, C.D.	C56318-101
266	3C336-23	COIL ASSEMBLY: 10 turns No. 22 DCC wire on moulded form (phenolic); 1-23/32″ long x 11/16″ dia. threaded 1/32″ one end.	CW osc. plate coil	Bendix	A106068-1

Note A.—Replace entire assembly in which this item is used.

Note B.—Replaceable with difficulty. Replace entire assembly in which item is used whenever possible.

*Any value from 600 to 1,000 mmf. acceptable. See table for alternate preference.

Reference Symbol	*Army Stock No. Navy Stock No. British Ref. No.*	*Name of Part and Description*	*Function*	*Mfr. and Desig. or AWS Type*	*Cont. or Govt. Dwg. or Spec. No.*
267	3D9004E7	CAPACITOR: Fixed; mica; 4.7 mmf. ±20%, 500 v.d.c.w., 1000 v.d.c.t.; 11/16" long x 7/16" wide x 13/64" thick, No. 20 tinned 1¼" leads, Aerovox Type 1468ST or 1468LST; Dubilier 5WLST, Micamold Type O or OXM, Sangamo Type K, Solar Type MOFW or MOCW. (Alternate 50 mmf. ±20%; 500 v.d.c.—ASACM20B050M).	CW osc. coupling	Aerovox, C.D. Micamold, Sangamo, Solar	C58469-047
268	3Z6647-19	RESISTOR: Fixed; composition; 47,000 ohms ±10%, 1 watt; Allen-Bradley Type GB; Bakelite insulated; 9/16" long x 7/32" dia., No. 18 leads 1½" long. (Alternate 47,000 ohms ±5%, 1 watt; ASARC30BF473J).	CW osc. screen (anode) dropping	Allen-Bradley	A112933-473
269	2C4439A/A3/2	INDUCTOR: Coil assembly; 10 turns No. 22 DCC wire, tapped 4½ turns from end opposite core adjusting screw; part of BFO can assembly No. 3C4439A/A3. (Note A).	CW osc. grid coil	Bendix	A105036-1
270	3D9008V-4	CAPACITOR: Variable; 8-10 mmf.; 2 rotors, 2 strators, 15/16" wide x 1-7/32" high, .25" dia. shaft. Hammerlund Type APC. (Note B).	CW osc. heat frequency control	Hamm.	A105041
271	3D9390	CAPACITOR: Fixed; mica; 390 mmf. ±5%, 500 v.d.c.w.; 11/16" long x 3/16" deep x 7/16" wide. No. 20 tinned leads 1¼" long. Aerovox Type 1469, C.D. Type 5R. (Note B). (Alternate ASACM20B391J).	CW osc. grid tuning	Aerovox, C.D.	C56317-391
272	2C4439A/A3	B.F.O. CAN ASSEMBLY: 3" high x 1½" x 2" base; 3 terminals; contains Ref. Nos. 269, 270, 271, 276-2.	Beat freq. osc.	Bendix	C58590-1
273	2Z8723.1	SOCKET: Dial light; for bayonet base type bulb; Amer. Radio Hdwe. Co. similar to Cat. No. 1539; straight bracket, overall dim. 1-31/32" long x 7/16" wide, mounting bracket slot ¾" long x 3/16" wide.	Dial light socket	Bendix	A104910
274	2C4439A/A2	OSCILLATOR ASSEMBLY: Contains Ref. Nos. 204-4, 204-5, 205-10 through -14, 218, 219-1, 219-2, 220, 221, 222, 223, 224, 225, 226, 276-1.		Bendix	N91052-1
275	2C4439A/A1	R.F. ASSEMBLY (including mixer and 1st I.F.): 2 mounting holes 1-13/16" center to center to clear No. 6-32 screws; contains Ref. Nos. 201, 202A, 202B, 202C, 203, 204-1, 204-2, 204-3, 205-1 through -9, 206, 207, 208, 209, 210, 211-1, 211-2, 212, 213, 214, 215-1, 216, 217.		Bendix	N91050-1

276-1	3DA1-58	CAPACITOR: Fixed; mica; 1000 mmfd. ± 20%, 500 volt test; No. 20 AWG leads 1-1/4" long, 11/16" long x 7/16" wide x 13/64" deep; Aerovox 1468ST or LST, Cornell-Dubilier 5WST, Micamold Type O, Sangamo Type K, Solar Type MOFW or MDCW. (Note B).	Osc. grid coupling	C.D., Aerovox Micamold, Sangamo, Solar	C58469-102
276-2	3DA1-58	Same as 276-1. (Note B).	CW osc. grid coupling	C.D., Aerovox Micamold, Sangamo, Solar	C58469-102
276-3	3DA1-58	Same as 276-1.	B + input filter	C.D., Aerovox Micamold, Sangamo, Solar	C58469-102
276-4	3DA1-58	Same as 276-1.	Heater input r-f filter	C.D., Aerovox Micamold, Sangamo, Solar	C58469-102
278-1	3RC30BE331K or 3ZK6033-19	RESISTOR: Fixed; carbon; 330 ohms ± 10%, 1 watt; JAN Type No. RC30BE331K	To balance impedance of line to Loudspeaker	JAN	
278-2		Same as 278-1			
VT-103	2J6SQ7	TUBE: JAN-6SQ7.	Det. 1st audio, a-v-c	Ken-rad, R.C.A.	
VT-152	2J6K6GT	TUBE: JAN-6K6GT.	2nd audio	Ken-Rad, R.C.A.	
VT-202	2J9002	TUBE: JAN-9002.	H-f oscillator	Ken-Rad, R.C.A.	
VT-203	2J9003	TUBE: JAN-9003.	R-f amplifier	Ken-Rad, R.C.A.	
VT-203	2J9003	TUBE: JAN-9003.	Mixer	Ken-Rad, R.C.A.	
VT-203	2J9003	TUBE: JAN-9003.	Doubler	Ken-Rad, R.C.A.	
VT-211	2J6SG7	TUBE: JAN-6SG7.	1st i-f amp.	Ken-Rad, R.C.A.	
VT-211	2J6SG7	TUBE: JAN-6SG7.	2nd i-f amp.	Ken-Rad, R.C.A.	
VT-211	2J6SG7	TUBE: JAN-6SG7.	3rd i-f amp.	Ken-Rad, R.C.A.	
VT-211	2J6SG7	TUBE: JAN-6SG7.	CW oscillator	Ken-Rad, R.C.A.	
	2Z8654.7	SOCKET: Tube; octal; 8 prong with No. 4 retainer ring; 1-1/4" dia. x 7/8" high; with ring 907658 grooved for a 1/32" to 1/16" panel; groove located 0.020" below mounting surface; for Tube VT-103; Amphenol Type S8TM.	Tube Socket	Amph.	A104087
	2Z8654.7	Same as above, for Tube VT-152.	Tube socket	Amph.	A104087

Note A.—Replace entire assembly in which this item is used.
Note B.—Replaceable with difficulty. Replace entire assembly in which item is used whenever possible.
*Any value from 600 to 1,000 mmf. acceptable. See table for alternate preference.

Reference Symbol	Army Stock No. Navy Stock No. British Ref. No.	Name of Part and Description	Function	Mfr. and Desig. or AWS Type	Cont. or Govt. Dwg. or Spec. No.
	2Z8654.7	Same as above, for Tube VT-211.	Tube socket	Amph.	A104087
	2Z8654.7	Same as above, for Tube VT-211.	Tube socket	Amph.	A104087
	2Z8654.7	Same as above, for Tube VT-211.	Tube socket	Amph.	A104087
	2Z8654.7	Same as above, for Tube VT-211.	Tube socket	Amph.	A104087
	2Z8657-3	SOCKET: Tube; octal; with ring; No. 2-9, 7 pin, 11/16″ lip, ⅝″ hole, ⅝″ deep, ⅞″ diam. retaining ring, for Tube VT-202, Amphenol Type 78-7 PT. (Note A).	Tube socket	Amph.	A102980
	2Z8657-3	Same as above, for Tube VT-203. (Note A).	Tube socket	Amph.	A102980
	2Z8657-3	Same as above, for Tube VT-203. (Note A).	Tube socket	Amph.	A102980
	2Z8657-3	Same as above, for Tube VT-203. (Note A).	Tube socket	Amph.	A102980
	2Z9402.81	TERMINAL BOARD ASSEMBLY: Capacitor and resistor; phenolic; 1/16″ thick x 2″ wide x 4″ long; includes Ref. Nos. 230-17, 236-4 and 5, 247, 248, 249, 250.	Terminal board	Bendix	A104850
	2Z9402.78	TERMINAL BOARD ASSEMBLY: Resistor and capacitor; phenolic; ⅛″ thick x ¼″ wide x 3⅜″ long; mounting holes centered in each end and centered ¼″ from edge; two other holes ⅝″ and 25/32″ respectively from left end; two holes 3/16″ from each side and spaced 19/32″ and 1-3/32″ respectively from right end; includes Ref. Nos. 255, 257, 261.	Terminal board	Bendix	A105008
	2Z9402.77	TERMINAL BOARD ASSEMBLY: Resistor and capacitor; phenolic; ⅛″ thick x 1⅜″ wide x 3¼″ long; five mounting holes 5/32″ from side and spaced beginning ⅝″ from left side, ⅝″, 1⅛″, 1-13/16″, 2-13/32″ and 2-13/32″; two mounting holes centered in each end and 3/16″ in from edge; complete with resistors and capacitors mounted; includes Ref. Nos. 230-19, 264, 265, 267, 268.	Terminal board	Bendix	A106052
	2Z9409.14	TERMINAL STRIP AND LUG ASSEMBLY: Phenolic; ⅛″ thick x ⅜″ wide x 4-21/32″ long; two mounting holes and six terminal pins.	Terminal board in R-f assembly	Bendix	A104914-1
	2Z9402.79	TERMINAL BOARD ASSEMBLY: Phenolic; ⅛″ thick x ⅜″ wide x 3-3/32″ long; four soldering pins and two spacers 5/16″ dia. x ⅝″ long.	Terminal board in H.F. osc. assembly	Bendix	A105058-1

2Z9416.17	TERMINAL BOARD ASSEMBLY: Phenolic; ⅛″ thick x 7/16″ wide x 12⅛″ long; four mounting holes, fifteen lug terminals.	Terminal board	Bendix	A105005
2C5539A/D1	DIAL: Calibrated 99 to 158 mc.; 4.00″ dia., .75″ dia. hole for shaft; 4 mounting holes 1″ center to center; 90° rotation.	Tuning indicator	Bendix	C58586
2Z5927	LAMP: LM-27; Bayonet; 6-8 volt, ¼ amp.; GE Mazda, Type 44; Bulb T-3-¼ Model ATU-26.	Illuminate dial	G.E.	A9320-1
2Z2643.2	CLAMP: Tube; used with 1¼″ tube base; mounting slot .144″ x .206″, 57/64″ apart; interchangeable with Birtcher Corp. No. 926-B.	Tube clamp	Westinghouse	A105391
2C4439A/F1	SHIELD: Contact; antenna socket fitting; 1-19/32″ dia. x .085″ flange, 29/32″ long overall; 3 No. 6-32 holes at 60°, 180° and 240° on flange 1.343″ dia.; 3 No. 40 countersunk holes at 120°, 240°, 0° on .875″ dia. center holes .532″ Hub 19/32″ O.D.	Antenna socket fitting	Bendix	A105912
2Z3290.3	COUPLING: Flexible; insulated brass ring in center fastened by flat springs to (2) stainless steel hubs; each drilled for ⅜″ dia. shaft; each hub has (2) holes tap No. 6-32 on 90° spacing cadmium plated 1½″ dia. x 11/16″ length.	Shaft coupling	Bendix	A104862-1
6R57400-6	WRENCH: Hex; L-shaped; 1/16″, .0615″ across flats; fits No. 5, 0.125″ and No. 6 Allen socket head set screw; No. 27397.	Wrench	Allen	A18190-6
2Z5854	POINTER AND KNOB ASSEMBLY: Black phenolic; 1⅛″ dia. x ⅝″ thick; (2) set screws 135° and 225° clockwise from pointer for .25″ diam. shaft (2) No. 8-32 set screws.	ON TONE CONTROL	K-K	A104855-1
2Z5854	Same as above.	ATTENUATION control	K-K	A104855-1
2Z5854	Same as above.	R-F GAIN INCREASE CONTROL	K-K	A104855-1
2Z5854	Same as above.	AUDIO GAIN INCREASE CONTROL	K-K	A104855-1
2Z5854	Same as above.	CW AND MANUAL-MANUAL A-V-C control	K-K	A104855-1

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*Any value from 600 to 1,000 mmf. acceptable. See table for alternate preference.

Reference Symbol	*Army Stock No. Navy Stock No. British Ref. No.*	*Name of Part and Description*	*Function*	*Mfr. and Desig. or AWS Type*	*Cont. or Govt. Dwg. or Spec. No.*
	2Z5786.7	KNOB ASSEMBLY: Cast with friction clutch; includes knob brass casting painted black; 2½″ dia. x 23/32″ deep; 2 holes for set screws; stainless steel hub type 303 with 0.251″ diameter holes; No. 6-32 tap holes at 0° and 90° counter-clockwise; O.D. 0.744″ shank 0.623″ O.D. x .724″ long; ⅜″-32 thread on end for 5/32″.	Tuning control	Bendix	A104891-1
	2Z4880-13	DIAL WINDOW: Transparent window with vertical hair line; 3-3/16″ long x 1-7/16″ wide x 0.060″ thick; 2 No. 40 DR. .098″ holes spaced 2.187″ center to center and 1-7/32″ from straight edge; white line 1¼″ from one end; 2 half circles each 21/32″ from white line, cut on 3/16″ radius one end chamfered to 45° "vinylite".	Identification	Bendix	A104906
	2Z3717.8	DIAL AND HUB: Frequency indicator; tuning; dial face 4″ dia., .020″ thick; (4) No. 40 holes 45° apart on 1″ dia.; center reamed .750″ periphery marked 100-155 for 270° align and stop; hub ¾″ dia. x .343″ long; brass spiral groove; 1 turn collar 1¼″ dia. x .038″ thick; (4) No. 40 DR. 45° apart on .749″ dia.; (2) set screws No. 6-32 fastener 3-3/16″ long x .01″ dia.; ring loop on end .063″ dia. Loop twist other end .031″ dia. x ⅛″ long; steel or nickel plated music wire.	Tuning	Bendix	A102604-1
	6D7400T639A	Instruction Book for Operation and Maintenance of Radio Receiver BC-639-A. Technical Order 8½″ x 11″.	Instruction	Bendix	
	2Z7242-25/1	SHIELD: Contact. (Part of Ref. No. 200).	Shield	Bendix	A102615

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73530-1
73531-1
73026-4
73028-2
8001-102
8001-102
8001-102
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8001-104
8001-104
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8001-104
8001-104
8001-221
8001-221
8001-221
8001-221
8001-473
8001-473
8001-473
8001-473
04484
04484
04194-4
05022
8961
8583
02975-105
02975-105
8469-331
8469-331
6336-18

REF. NO.	DESCRIPTION	DWG. NO.
247	220 MMF, 500V DCW CAP.	C58469-221
248	0.1 MFD, 400V DCW CAP.	A18015-104
249	18,000 OHMS, ¼W RES.	A18001-183
250	2,200 OHMS, ¼W RES.	A18001-222
251	1 MEG, VOLUME CONTROL	A102616
252	68,000 OHMS, ½W RES.	A102975-683
253-1	33,000 OHMS, ½W RES.	A102975-333
253-2	33,000 OHMS, ½W RES.	A102975-333
254	ATTENUATOR SWITCH	C58584
255	330,000 OHMS, ½W RES.	A102975-334
256	560 OHMS, 2W RES.	RC41BE561J
257	.0068 MFD, 500V DCW CAP.	A25714-7
258	OUTPUT TRANS.	A103058
259	PRI. OUTPUT TRANS.	A103058
260	SEC. OUTPUT TRANS.	A103058
261	4700 OHMS, ¼W RES.	A18001-472
262-1	PHONE JACK	A103533
262-2	PHONE JACK	A103533
263	JONES PLUG	A105106
264	4700 OHMS, ½W RES.	A18004-472
265	100 MMF, 500V DCW CAP.	C56317-101
266	C.W. OSC. PLATE COIL	AA106068
267	4.7 MMF, 500V DCW CAP.	C58469-47
268	47,000 OHMS, ½W RES.	A18004-473
269	C.W. OSC. GRID COIL	A105036-1
270	VARIABLE CAP.	A105041
271	390 MMF, 500V DCW CAP.	C56317-391
272	C.W. OSC. COIL ASSEM.	C58590-1
273	DIAL LIGHT ASSEM.	A104910
274	H.F. OSC. ASSEMBLY	AN91052-1
275	R.F. ASSEMBLY	AN91050-1
276-1	.001MFD, 500V DCW CAP.	C58469-102
276-2	.001MFD, 500V DCW CAP.	C58469-102
276-3	.001MFD, 500V DCW CAP.	C58469-102
276-4	.001MFD, 500V DCW CAP.	C58469-102
278-1	330 OHMS, 1W RES.	RC30BE331K
278-2	330 OHMS, 1W RES.	RC30BE331K
VT-103	DET., 1ST AUDIO, AVC	
VT-152	2ND AUDIO	
VT-202	H.F. OSC.	
VT-203	R.F. AMPLIFIER	
VT-203	MIXER	
VT-203	DOUBLER	
VT-211	1ST I.F.	
VT-211	2ND I.F.	
VT-211	3RD I.F.	
VT-211	C.W. OSC.	

REF N
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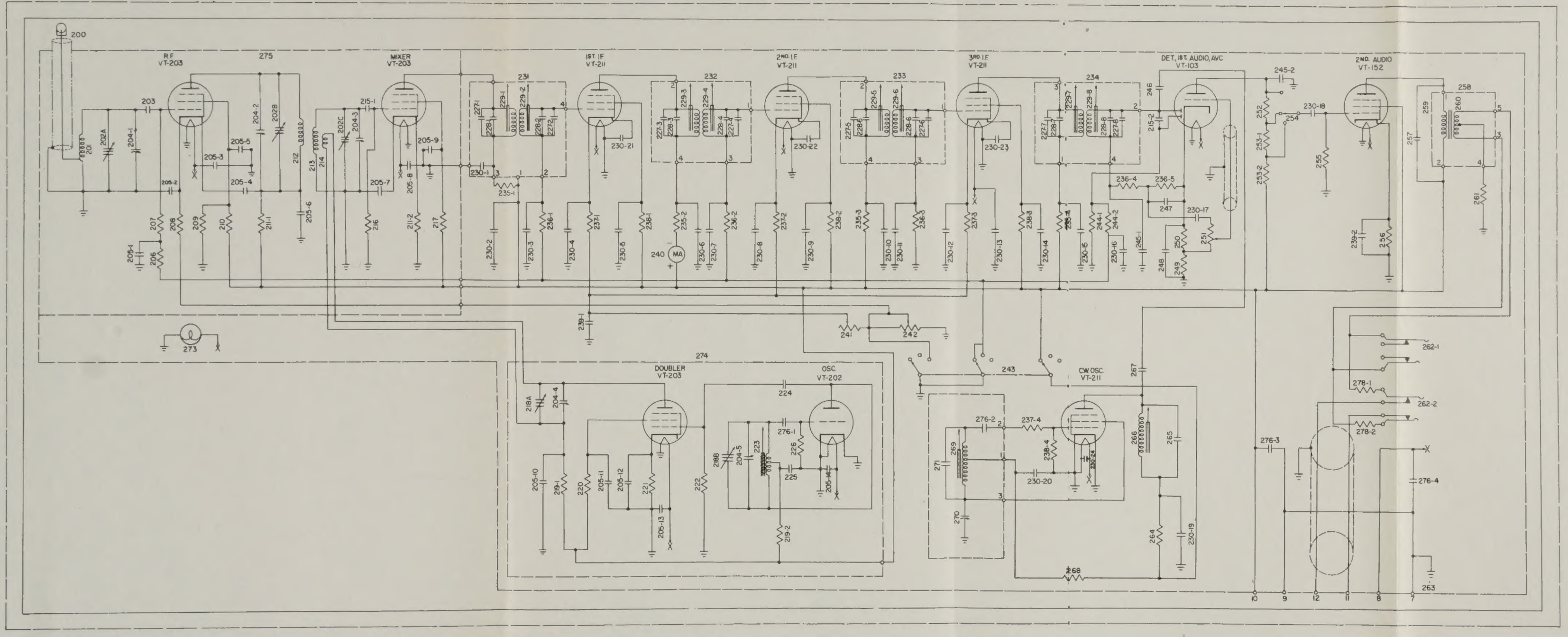
Figure 22 — Radio Receiver BC-639-A, Schematic Diagram

Reference Symbol	*Army Stock No. Navy Stock No. British Ref. No.*	*Name of Part and Description*	*Function*	*Mfr. and Desig. or AWS Type*	*Cont. or Govt. Dwg. or Spec. No.*
	2Z5786.7	KNOB ASSEMBLY: Cast with friction clutch; includes knob brass casting painted black; 2½″ dia. x 23/32″ deep; 2 holes for set screws; stainless steel hub type 303 with 0.251″ diameter holes; No. 6-32 tap holes at 0° and 90° counter-clockwise; O.D. 0.744″ shank 0.623″ O.D. x .724″ long; ⅜″-32 thread on end for 5/32″.	Tuning control	Bendix	A104891-1
	2Z4880-13	DIAL WINDOW: Transparent window with vertical hair line; 3-3/16″ long x 1-7/16″ wide x 0.060″ thick; 2 No. 40 DR. .098″ holes spaced 2.187″ center to center and 1-7/32″ from straight edge; white line 1¼″ from one end; 2 half circles each 21/32″ from white line, cut on 3/16″ radius one end chamfered to 45° "vinylite".	Identification	Bendix	A104906
	2Z3717.8	DIAL AND HUB: Frequency indicator; tuning; dial face 4″ dia., .020″ thick; (4) No. 40 holes 45° apart on 1″ dia.; center reamed .750″ periphery marked 100-155 for 270° align and stop; hub ¾″ dia. x .343″ long; brass spiral groove; 1 turn collar 1¼″ dia. x .038″ thick; (4) No. 40 DR. 45° apart on .749″ dia.; (2) set screws No. 6-32 fastener 3-3/16″ long x .01″ dia.; ring loop on end .063″ dia. Loop twist other end .031″ dia. x ⅛″ long; steel or nickel plated music wire.	Tuning	Bendix	A102604-1
	6D7400T639A	Instruction Book for Operation and Maintenance of Radio Receiver BC-639-A. Technical Order 8½″ x 11″.	Instruction	Bendix	
	2Z7242-25/1	SHIELD: Contact. (Part of Ref. No. 200).	Shield	Bendix	A102615

Note A.—Replace entire assembly in which this item is used.

Note B.—Replaceable with difficulty. Replace entire assembly in which item is used whenever possible.

*Any value from 600 to 1,000 mmf. acceptable. See table for alternate preference.



REF. NO.	DESCRIPTION	DWG. NO.
200	ANTENNA PLUG	C58585
201	ANTENNA COIL	A105064
202	GANG CAP (3 SEC)	L72799-2
203	15MMF, 500V DCW CAP.	C58469-150
204-1	TRIMMER CAP.	L72799-2
204-2	TRIMMER CAP.	L72799-2
204-3	TRIMMER CAP.	L72799-2
204-4	TRIMMER CAP.	L72799-2
204-5	TRIMMER CAP.	L72799-2
205-1	680MMF, 500V DCW CAP. *	C58469-102
205-2	680MMF, 500V DCW CAP. *	C58469-102
205-3	680MMF, 500V DCW CAP. *	C58469-102
205-4	680MMF, 500V DCW CAP. *	C58469-102
205-5	680MMF, 500V DCW CAP. *	C58469-102
205-6	680MMF, 500V DCW CAP. *	C58469-102
205-7	680MMF, 500V DCW CAP. *	C58469-102
205-8	680MMF, 500V DCW CAP. *	C58469-102
205-9	680MMF, 500V DCW CAP. *	C58469-102
205-10	680MMF, 500V DCW CAP. *	C58469-102
205-11	680MMF, 500V DCW CAP. *	C58469-102
205-12	680MMF, 500V DCW CAP. *	C58469-102
205-13	680MMF, 500V DCW CAP. *	C58469-102
205-14	680MMF, 500V DCW CAP. *	C58469-102
205-15	680MMF, 500V DCW CAP. *	C58469-102
205-16	680MMF, 500V DCW CAP. *	C58469-102
205-17	680MMF, 500V DCW CAP. *	C58469-102
205-18	680MMF, 500V DCW CAP. *	C58469-102
206	100,000 OHMS, ½W RES.	A102975-104
207	560,000 OHMS, ½W RES.	A102975-564
208	330 OHMS, ½W RES.	A102975-331
209	120,000 OHMS, ½W RES.	A102975-124
210	39,000 OHMS, ½W RES.	A18004-393
211-1	1,000 OHMS, ½W RES.	A102975-102
211-2	1,000 OHMS, ½W RES.	A102975-102
212	R.F. PLATE COIL	A105065
213	MIXER GRID COIL	A105066
214	DOUBLER PLATE COIL	A104311
215-1	47MMF, 500V DCW CAP.	C58469-470
215-2	47MMF, 500V DCW CAP.	C58469-470
216	1.8 MEGOHMS ½W RES.	A102975-185
217	270,000 OHMS ½W RES.	A102975-274
218	GANG CAP. (2 SEC)	L72798-2
219-1	4,700 OHMS ½W RES.	A102975-472
219-2	4,700 OHMS ½W RES.	A102975-472
220	56,000 OHMS ½W RES.	A102975-563
221	560 OHMS ½W RES.	A102975-561
222	27,000 OHMS ½W RES.	A102975-273
223	H.F. OSC. COIL	A105061
224	27MMF, 500V DCW CAP.	C58469-270
225	150MMF, 500V DCW CAP.	C58469-151
226	47,000 OHMS ½W RES.	A102975-473
227-1	15MMF, 500V DCW CAP.	A25715-15
227-2	15MMF, 500V DCW CAP.	A25715-15
227-3	15MMF, 500V DCW CAP.	A25715-15
227-4	15MMF, 500V DCW CAP.	A25715-15
227-5	15MMF, 500V DCW CAP.	A25715-15
227-6	15MMF, 500V DCW CAP.	A25715-15
227-7	15MMF, 500V DCW CAP.	A25715-15
227-8	15MMF, 500V DCW CAP.	A25715-15
228-1	60MMF, 500V DCW CAP.	C58495-600
228-2	60MMF, 500V DCW CAP.	C58495-600
228-3	60MMF, 500V DCW CAP.	C58495-600
228-4	60MMF, 500V DCW CAP.	C58495-600
228-5	60MMF, 500V DCW CAP.	C58495-600
228-6	60MMF, 500V DCW CAP.	C58495-600
228-7	60MMF, 500V DCW CAP.	C58495-600
228-8	60MMF, 500V DCW CAP.	C58495-600
229-1	IF COIL	AA104206-1
229-2	IF COIL	AA104206-1
229-3	IF COIL	AA104206-1
229-4	IF COIL	AA104206-1
229-5	IF COIL	AA104206-1
229-6	IF COIL	AA104206-1
229-7	IF COIL	AA104206-1
229-8	IF COIL	AA104206-1
230-1	.0068MFD, 500V DCW CAP. **	A102967-8
230-2	.0068MFD, 500V DCW CAP. **	A102967-8
230-3	.0068MFD, 500V DCW CAP. **	A102967-8
230-4	.0068MFD, 500V DCW CAP. **	A102967-8
230-5	.0068MFD, 500V DCW CAP. **	A102967-8
230-6	.0068MFD, 500V DCW CAP. **	A102967-8
230-7	.0068MFD, 500V DCW CAP. **	A102967-8
230-8	.0068MFD, 500V DCW CAP. **	A102967-8
230-9	.0068MFD, 500V DCW CAP. **	A102967-8
230-10	.0068MFD, 500V DCW CAP. **	A102967-8
230-11	.0068MFD, 500V DCW CAP. **	A102967-8
230-12	.0068MFD, 500V DCW CAP. **	A102967-8
230-13	.0068MFD, 500V DCW CAP. **	A102967-8
230-14	.0068MFD, 500V DCW CAP. **	A102967-8
230-15	.0068MFD, 500V DCW CAP. **	A102967-8
230-16	.0068MFD, 500V DCW CAP. **	A102967-8
230-17	.0068MFD, 500V DCW CAP. **	A102967-8
230-18	.0068MFD, 500V DCW CAP. **	A102967-8
230-19	.0068MFD, 500V DCW CAP. **	A102967-8
230-20	.0068MFD, 500V DCW CAP. **	A102967-8
230-21	.0068MFD, 500V DCW CAP. **	A102967-8
230-22	.0068MFD, 500V DCW CAP. **	A102967-8
230-23	.0068MFD, 500V DCW CAP. **	A102967-8
231	1ST I.F. ASSEM.	AL73530-1
232	2ND I.F. ASSEM.	AL73531-1
233	3RD I.F. ASSEM.	AL73026-4
234	4TH I.F. ASSEM.	AL73028-2
235-1	1,000 OHMS, ¼W RES.	A18001-102
235-2	1,000 OHMS, ¼W RES.	A18001-102
235-3	1,000 OHMS, ¼W RES.	A18001-102
235-4	1,000 OHMS, ¼W RES.	A18001-102
236-1	100,000 OHMS, ¼W RES.	A18001-104
236-2	100,000 OHMS, ¼W RES.	A18001-104
236-3	100,000 OHMS, ¼W RES.	A18001-104
236-4	100,000 OHMS, ¼W RES.	A18001-104
236-5	100,000 OHMS, ¼W RES.	A18001-104
237-1	220 OHMS, ¼W RES.	A18001-221
237-2	220 OHMS, ¼W RES.	A18001-221
237-3	220 OHMS, ¼W RES.	A18001-221
237-4	220 OHMS, ¼W RES.	A18001-221
238-1	47,000 OHMS ¼W RES.	A18001-473
238-2	47,000 OHMS ¼W RES.	A18001-473
238-3	47,000 OHMS ¼W RES.	A18001-473
238-4	47,000 OHMS ¼W RES.	A18001-473
239-1	1.0 MFD, 100V DCW CAP.	A104484
239-2	1.0 MFD, 100V DCW CAP.	A104484
240	0-10 MILLAMMETER	A104194-4
241	300 OHMS, THES. CONTROL	A105022
242	3000 OHMS, GAIN CONTROL	C58961
243	SELECTOR SWITCH	C58583
244-1	1 MEGOHM, ½W RES.	A102975-105
244-2	1 MEGOHM, ½W RES.	A102975-105
245-1	330 MMF, 500V DCW CAP.	C58469-331
245-2	330 MMF, 500V DCW CAP.	C58469-331
246	1.8 MMF, 500V DCW CAP.	C56336-18
247	220 MMF, 500V DCW CAP.	C58469-221
248	0.1 MFD, 400V DCW CAP.	A18015-104
249	18,000 OHMS, ¼W RES.	A18001-183
250	2,200 OHMS, ¼W RES.	A18001-222
251	1 MEG, VOLUME CONTROL	A102616
252	68,000 OHMS, ½W RES.	A102975-683
253-1	33,000 OHMS, ½W RES.	A102975-333
253-2	33,000 OHMS, ½W RES.	A102975-333
254	ATTENUATOR SWITCH	C58584
255	330,000 OHMS, ½W RES.	A102975-334
256	560 OHMS, 2W RES.	RC41BE561J
257	.0068 MFD, 500V DCW CAP.	A25714-7
258	OUTPUT TRANS.	A103058
259	PRI. OUTPUT TRANS.	A103058
260	SEC. OUTPUT TRANS.	A103058
261	4700 OHMS, ¼W RES.	A18001-472
262-1	PHONE JACK	A103533
262-2	PHONE JACK	A103533
263	JONES PLUG	A105106
264	4700 OHMS, ½W RES.	A18004-472
265	100 MMF, 500V DCW CAP.	C56317-101
266	C.W. OSC. PLATE COIL	AA106068
267	4.7 MMF, 500V DCW CAP.	C58469-47
268	47,000 OHMS, ½W RES.	A18004-473
269	C.W. OSC. GRID COIL	A105036-1
270	VARIABLE CAP.	A105041
271	390 MMF, 500V DCW CAP.	C56317-391
272	C.W. OSC. COIL ASSEM.	C58590-1
273	DIAL LIGHT ASSEM.	A104910
274	H.F. OSC. ASSEMBLY	AN91052-1
275	R.F. ASSEMBLY	AN91050-1
276-1	.001MFD, 500V DCW CAP.	C58469-102
276-2	.001MFD, 500V DCW CAP.	C58469-102
276-3	.001MFD, 500V DCW CAP.	C58469-102
276-4	.001MFD, 500V DCW CAP.	C58469-102
278-1	330 OHMS, 1W RES.	RC30BE331K
278-2	330 OHMS, 1W RES.	RC30BE331K
VT-103	DET., 1ST AUDIO, AVC	
VT-152	2ND AUDIO	
VT-202	H.F. OSC.	
VT-203	R.F. AMPLIFIER	
VT-203	MIXER	
VT-203	DOUBLER	
VT-211	1ST I.F.	
VT-211	2ND I.F.	
VT-211	3RD I.F.	
VT-211	C.W. OSC.	

* ANY VALUE FROM 1000 MMF TO 600 MMF. IS ACCEPTABLE.

** ANY VALUE FROM .01MFD TO .006 MFD IS ACCEPTABLE.

Figure 22 – Radio Receiver BC-639-A, Schematic Diagram

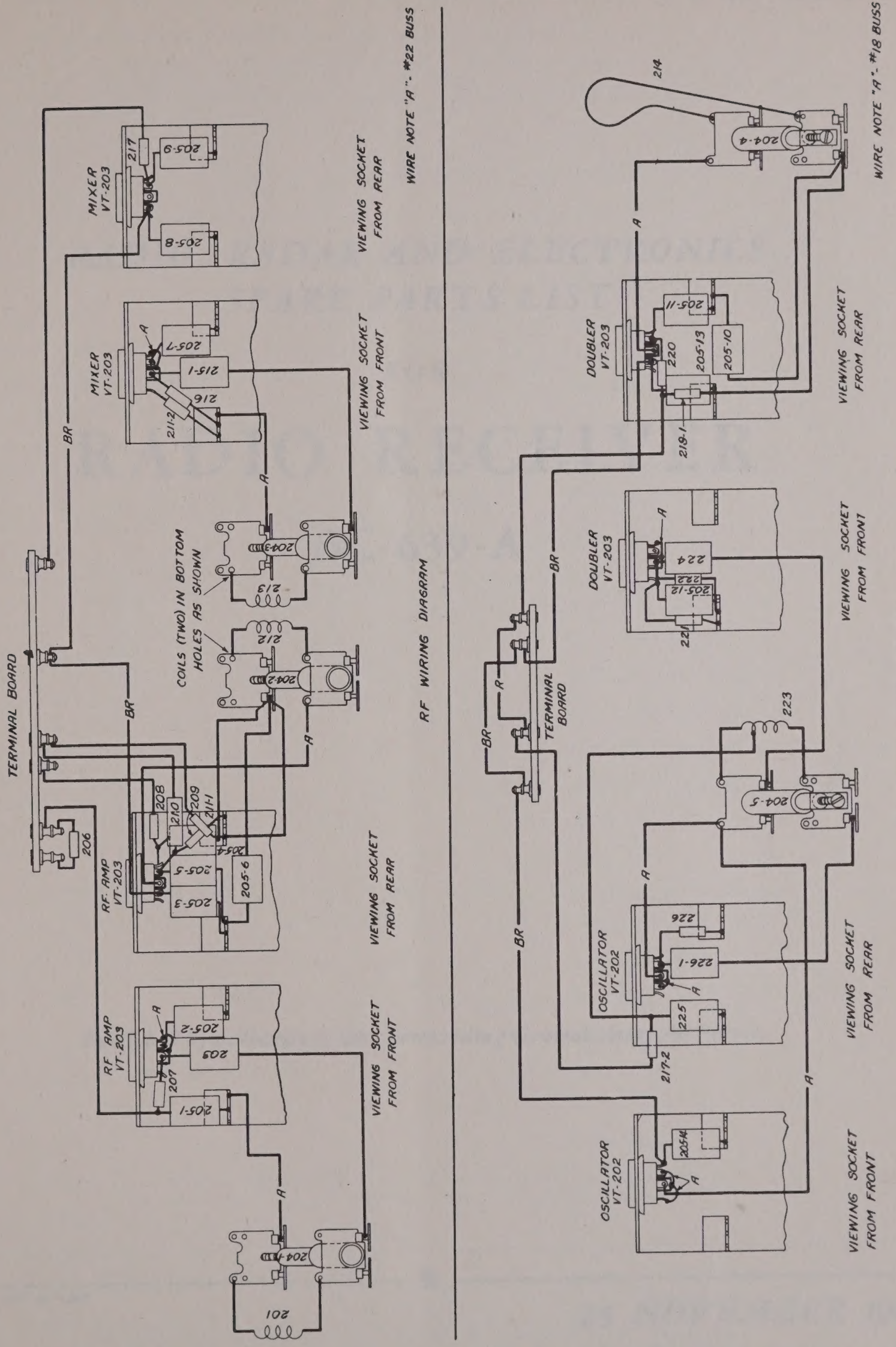

TERMINAL BOARD
206
RF AMP
VT-203
207
205-1
205-2
203
A
VIEWING SOCKET
FROM FRONT
201
204-1
R.F. AMP
VT-203
205-3
205-5
205-6
205-4
208
210
209
211-1
VIEWING SOCKET
FROM REAR
BR
A
204-2
212
213
204-3
COILS (TWO) IN BOTTOM
HOLES AS SHOWN
RF WIRING DIAGRAM
MIXER
VT-203
205-7
215-1
216
211-2
VIEWING SOCKET
FROM FRONT
MIXER
VT-203
217
205-9
205-8
VIEWING SOCKET
FROM REAR
WIRE NOTE "A" - #22 BUSS
OSCILLATOR
VT-202
205-14
VIEWING SOCKET
FROM FRONT
OSCILLATOR
VT-202
225
226
226-1
217-2
VIEWING SOCKET
FROM REAR
204-5
223
TERMINAL
BOARD
BR
R
DOUBLER
VT-203
224
222
205-12
221
VIEWING SOCKET
FROM FRONT
OSCILLATOR WIRING DIAGRAM
DOUBLER
VT-203
220
205-11
205-13
205-10
219-1
VIEWING SOCKET
FROM REAR
204-4
214
WIRE NOTE "A" - #18 BUSS

Figure 23 — Radio Receiver BC-639-A, R. F. and Oscillator Wiring Diagram

T. O. NO. 16-55-321

RADIO, RADAR AND ELECTRONICS SPARE PARTS LIST

FOR

RADIO RECEIVER

BC-639-A

Published by Authority of the Commanding General, Army Air Forces.

WF-O-20 DEC 46 4,600

25 NOVEMBER 1946

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SECTION I
INTRODUCTION

This Spare Parts List contains items and quantity allowances for replacement and maintenance of Radio Receiver BC-639-A, AAF Stock No. 1700-217252000. Parts enumerated in this list are required for maintaining 10 Radio Receiver BC-639-A equipments for a period of one year's operation.

The following is the major assembly for which this parts list enumerates maintenance items and quantities:

Assembly	*AAF Part Number*
Radio Receiver BC-639-A	2C4439A

AAF Stock Number
1700-217252000

An explanation of the various columns in Section II is as follows:

a. "Item Number" is a sequence number indicating numerical order of listing. The item numbers assigned herein pertain only to this equipment.

b. "Reference Symbol" contains reference symbols appearing on schematics, sketches, photographs, etc. pertaining to this equipment.

c. "Description of Part" contains the nomenclature, description of the item, and the part number.

d. "Mfr Part No." contains the JAN, drawing, type, or other designation number.

e. "AAF Stock No." contains the Army Air Forces stock number.

f. "Spare Qty" is the total spare quantity of the item originally supplied with each Radio Receiver BC-639-A.

g. "Maint Qty" is the total quantity (in addition to the spare quantity) required for maintaining 10 Radio Receiver BC-639-A equipments for a period of one year's operation.

Abbreviations and symbols used in this parts list and their meanings are as follows:

Abbreviation	*Term*
adj	adjust, adjustable or adjustment
AF	audio frequency
amp	ampere(s)
assem	assembly
bkt	bracket(s)
c/o	consisting of
coef	coefficient
comp	composition
cond	conductor(s)
cont	contact(s)
d	deep or depth
DC	direct current
deg	degree(s)
diam	diameter
E	enameled
ea	each
encl	enclosed(ure)
fil	filament(s)
fl	flange
FMS	from mounting surface
freq	frequency(ies)
ft	foot or feet
gnd	ground(ed)
h	high
HS	hermetically sealed
IF	intermediate frequency
impr	impregnate (ed) (ion)
incl	includes, included, inclusive, including
ins	insulating, insulated or insulator(s)
int	internal
lg	long
log	logarithm or logarithmic
ltr	letter
ma	milliampere(s)
max	maximum
mc	megacycle(s)
mf	microfarad
mmf	micromicrofarad
mtg	mounting(s)
mtg/c	mounting center(s)
mts	mounts
mw	milliwatt(s)
oper	operating
±	plus or minus
%	per cent
p/o	part of

Abbreviation	*Term*
pl	plated
pol	polarized
pri	primary(ies)
RF	radio frequency
RSW	resistant to salt water
Sig C	Signal Corps
secd	secondary(ies)
spec	specification(s)
std	standard
temp	temperature
term	terminal(s)
thk	thick
UHF	ultra high frequency
v	volt(s)
vdcw	DC working volts
w	watt(s)
wd	wide
wnd	wound
w/o	without

NOTE:

To expedite the delivery of spares, the AAF stock number should always be supplied with all requisitions if possible. However, if the stock number is not available, use should be made of the AAF part number, the manufacturer's part number, the nomenclature of the part and the item number (mentioning the Technical Order and the date thereof from which obtained). Such pertinent data contributing to adequate definition of parts, if supplied with requisitions, may well avoid costly delay in procurement.

SECTION II
SPARE PARTS LIST

Item No.	*Reference Symbol*	*Description of Part*	*Mfr Part No.*	*AAF Stock No.*	*Spare Qty*	*Maint Qty*
1	246	CAPACITOR, fixed: mica; 1.8 mmf ±50%; 500 vdcw; temp coef ltr "B"; 45/64" lg x 29/64" wd x 3/16" thk; molded bakelite case; 2 axial wire leads; RSW (3D9001E8)	Aerovox type 1468S	3300-312718000	1	2
2	267	CAPACITOR, fixed: mica; 4.7 mmf ±20%; 500 vdcw; temp coef ltr "B"; 11/16" lg x 7/16" wd x 3/16" h; molded low-loss bakelite case; 2 axial wire leads; RSW (3D9004E7)	Dubilier type 5-WLST	3300-312814000	1	2
3	227-1 thru 227-8	CAPACITOR, fixed: ceramic; 15 mmf ±5%; negative temp coef 680 (tol ± 102) mmf/mf/°C; 500 vdcw; 7/16" lg x 7/32" diam; axial wire leads; ceramic insulation (3D9015-9)	Erie style N680K-15	3300-313076000	1	8
4	215-2	CAPACITOR, fixed: silver mica; 47 mmf ±10%; 500 vdcw; spec JAN-C-5 (3K2047031)	CM20C470K	3300-376033600 CUI	1	2
5	228-1 thru 228-8	CAPACITOR, fixed: silver mica; 60 mmf ±2%; 500 vdcw; temp coef ltr "B"; 45/64" lg x 29/64" wd x 3/16" thk; molded low-loss bakelite case; 2 axial wire leads; RSW (3D9060-1)	Aerovox type 1469LS	3300-313602000 CUI	1	8
6	265	CAPACITOR, fixed: silver mica; 100 mmf ±5%; 500 vdcw; spec JAN-C-5 (3K2010132)	CM20C101J	3300-376002800 CUI	1	2
7	247	CAPACITOR, fixed: silver mica; 220 mmf ±20%; 500 vdcw; spec JAN-C-5 (3K2022134)	CM20C221M	3300-376017220	1	2
8	245-1 245-2	CAPACITOR, fixed: mica; 330 mmf ±20%; 500 vdcw; spec JAN-C-5 (3K2033124)	CM20B331M	3300-376026000	1	3
9	257	CAPACITOR, fixed: mica; 6800 mmf ±20%; 300 vdcw; spec JAN-C-5 (3K3568224)	CM35B682M	3300-376155830 CUI	1	2
10	230-1 thru 230-24	CAPACITOR, fixed: silver mica; 10,000 mmf ±10%; 300 vdcw; spec JAN-C-5 (3K3510331)	CM35C103K	3300-376144100	2	16
11	248	CAPACITOR, fixed: paper; 100,000 mmf ±10%; 400 vdcw; molded bakelite case; 1 7/16" lg x 3/4" wd x 3/8" thk; wax impr; 2 axial wire leads; no int gnd connections (3DA100-124)	Micamold type 345-21	3300-316406000 CUI	1	2
12	239-1 239-2	CAPACITOR, fixed: paper; 1 mf ±20%—15%; 100 vdcw; HS metal case; 1 13/16" lg x 1" wd x 7/8" h; castor oil filled; 2 solder lug term on side; no int gnd connections; 2 integral mtg ft ea w/ single 3/16" diam hole on 2 1/8" mtg/c (3DB1.092)	Bendix A104092-2	3300-316778230	1	3
13	266	COIL, RF: choke; single wnd, single layer wnd; unshielded; 10 turns No. 22 AWG DC wire; 1 23/32" lg x 11/16" diam; solid phenolic form and core; one end threaded 7/32" lg for mtg (3C336-23)	Bendix A106068-1	3300-307768000		1

Item No.	Reference Symbol	Description of Part	Mfr Part No.	AAF Stock No.	Spare Qty	Maint Qty
14	200	CONNECTOR, female contact: single round female cont; straight; 2 7/8" lg x 2 3/16" diam; cylindrical brass body, silver pl; cable opening 0.188" diam; three 0.098" drilled mtg holes 120 deg apart on 7/8" rad (2Z7097-3)	Bendix AC58585	3300-293531500		1
15	263	CONNECTOR, male contact: 6 pol male blade type cont; straight; 1 7/16" lg x 1" wd x 13/16" d less cont; rectangular molded bakelite body; two 0.147" diam mtg holes on 2 1/16" mtg/c (2Z7228.29)	Jones HB type P-406-AB	8800-59609223		1
16	262-1 262-2	JACK, telephone: Sig C Jack JK-42; for 3 cond plug 0.25" diam; 3 23/64" lg x 9/16" wd x 7/8" h; cont arrangement J-7; 29/64" diam mtg hole; 5/32" diam hole (2Z5542)	Bendix A104574	3300-291848000		1
17		KNOB: round; black phenolic; for 1/4" diam shaft; two No. 8-32 set screws; 1 1/8" diam x 45/64" h; brass insert; shaft hole 33/64" d; insert protrudes 1/16" beyond hub (2Z5788-1)	Kurz-Kasch type S-308-64	8800-438300		2
18		KNOB: round; brass, black E; for 1/4" diam shaft; two No. 6-32 set screws; 2 1/2" diam x 23/32" h; shaft hole 9/16" d; knob fluted (2Z5787.7)	Bendix A104891	3300-292181330		1
19		LAMP, incandescent: Sig C Lamp LM-27; 6 to 8 v, 0.25 amp; bulb T-3-1/4 clear; 15/16" lg; miniature bayonet base; C-2 fil; burn any position (2Z5927)	Mazda type 44	8800-444200	4	20
20	273	LAMPHOLDER: miniature bayonet base; brass body; 6 to 8 v, 15 amp; 1 1/4" lg x 13/32" wd x 3/8" thk; mtg bkt w/ 3/4" lg x 3/16" wd slot for adj mtg; bkt on side of socket w/ 2 solder lugs on opposite side (2Z8723.1)	Amer Rad Hdwe catalog 1539	3300-296010500		1
21	240	METER, ammeter: DC; 0 to 10 ma; round plastic flush mtg/c; barrel diam 2.20", 0.89" d behind panel, round fl 2.69" diam; 2% accuracy; D'Arsonval movement; calibrated for 1/8" thk steel panel; 20 scale divisions, black numerals on white background; self-contained; three 0.125" diam mtg holes 120 deg apart on 1.22" rad; 2 stud term 1/4"-28 x 3/4" lg (3F901-5)	Weston model No. 506	3300-325282000		1
22	274	OSCILLATOR, RF: freq range 11.9 to 12.1 mc; 10 mw output; 5 3/16" lg x 4 3/8" wd x 4" h; integral coils; receives power from main rectifier unit; incl 2 tubes, 6 capacitors, 5 resistors, 2 coils, tube sockets, term board assem; mts in metal cabinet (2C4439A/A2)	Bendix AN91052-1	3300-217262000		1
23	272	OSCILLATOR, RF: freq range 11.9 to 12.1 mc; 10 mw output; 4" lg x 2 7/16" h x 1 1/2" wd; integral coil; receives power from main rectifier unit; incl 3 capacitors and 1 coil; mts in metal cabinet (2C4439A/A3)	Bendix C58590-1	3300-217268000		1
24	237-1 thru 237-4	RESISTOR, fixed: comp; 220 ohms ±5%; 1/2 w; spec JAN-R-11 (3RC20AE221J)	RC20AE221J	3300-381152020 CUI	2	14

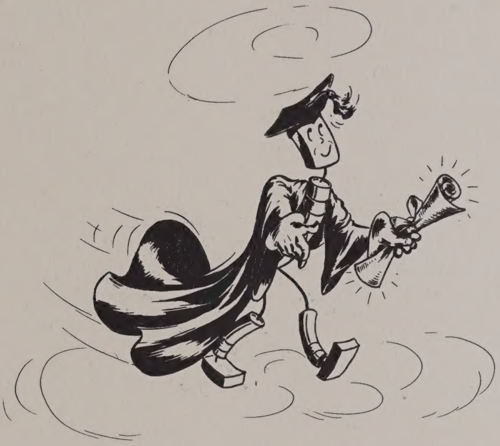
Item No.	*Reference Symbol*	*Description of Part*	*Mfr Part No.*	*AAF Stock No.*	*Spare Qty*	*Maint Qty*
25	256	RESISTOR, fixed: comp; 560 ohms ±5%; 2 w; spec JAN-R-11 (3RC41BE561J)	RC41BE561J	3300-381564800	1	3
26	235-1 thru 235-4	RESISTOR, fixed: comp; 1000 ohms ±5%; ½ w; spec JAN-R-11 (3RC20AE102J)	RC20AE102J	3300-381150120 CUI	2	14
27	250	RESISTOR, fixed: comp; 2200 ohms ±5%; ½ w; spec JAN-R-11 (3RC20AE222J)	RC20AE222J	3300-381152080 CUI	1	3
28	261	RESISTOR, fixed: comp; 4700 ohms ±5%; ½ w; spec JAN-R-11 (3RC20AE472J)	RC20AE472J	3300-381153760 CUI	1	3
29	264	RESISTOR, fixed: comp; 4700 ohms ±5%; 1 w; spec JAN-R-11 (3RC31AE472J)	RC31AE472J	3300-381353760	1	3
30	249	RESISTOR, fixed: comp; 18,000 ohms ±5%; ½ w; spec JAN-R-11 (3RC20AE183J)	RC20AE183J	3300-381151660	1	3
31	253-1 253-2	RESISTOR, fixed; comp; 33,000 ohms ±5%; ½ w; spec JAN-R-11 (3RC20BE333J)	RC20BE333J	3300-381163620 CUI	1	5
32	238-1 thru 238-4	RESISTOR, fixed: comp; 47,000 ohms ±5%; ½ w; spec JAN-R-11 (3RC20AE473J)	RC20AE473J	3300-381153820 CUI	2	14
33	268	RESISTOR, fixed: comp; 47,000 ohms ±5%; 1 w; spec JAN-R-11 (3RC31AE473J)	RC31AE473J	3300-381353820 CUI	1	3
34	252	RESISTOR, fixed: comp; 68,000 ohms ±10%; ½ w; spec JAN-R-11 (3RC20BE683K)	RC20BE683K	3300-381165320 CUI	1	3
35	236-1 thru 236-5	RESISTOR, fixed: comp; 100,000 ohms ±5%; ½ w; spec JAN-R-11 (3RC20AE104J)	RC20AE104J	3300-381150240 CUI	2	15
36	255	RESISTOR, fixed: comp; 330,000 ohms ±5%; ½ w; spec JAN-R-11 (3RC20AE334J)	RC20AE334J	3300-381153040 CUI	1	3
37	244-1 244-2	RESISTOR, fixed: comp; 1 meg ±5%; ½ w; spec JAN-R-11 (3RC20BE105J)	RC20BE105J	3300-381160940 CUI	1	5
38	241	RESISTOR, variable: comp; 300 ohms ±20%; 2 w; 100°C max continuous oper temp; 3 solder lug term; encl molded bakelite body w/ metal cover or case 1$\frac{1}{16}$" diam x $\frac{9}{16}$" d, round metal shaft ¼" diam x 2" lg FMS; linear taper; ins cont arm, w/o off position; normal torque; bushing ⅜"-32 x ¼" lg (2Z7262-3)	AB type No. J	3300-294442000	1	2

Item No.	Reference Symbol	Description of Part	Mfr Part No.	AAF Stock No.	Spare Qty	Maint Qty
39	242	RESISTOR, variable: comp; 3000 ohms ±20%; 2 w, 100°C max continuous oper temp; 3 solder lug term; encl molded bakelite body w/ metal cover or case 1 1/16″ diam x 9/16″ d; round metal shaft ¼″ diam x 15/16″ lg FMS; log taper; ins cont arm, w/o off position; normal torque; bushing ⅜″-32 x ¼″ lg (2Z7262-3M)	Bendix C58961A	3300-294443500	1	2
40	251	RESISTOR, variable: comp; 1 meg ±20%; 2 w, 100°C max continuous oper temp; 3 solder lug term; encl molded bakelite body w/ metal cover or case 1 1/16″ diam x 9/16″ d; round metal shaft ¼″ diam x 1″ lg FMS; log taper; ins cont arm, w/o off position; normal torque; bushing ⅜″-32 x ¼″ lg (2Z7262.1)	AB type No. J	3300-294437500	1	2
41		SOCKET, tube: std octal; No. 4 retainer ring mtg; 2 mtg holes on 1½″ mtg/c; round mica filled bakelite body, 1¼″ diam x 1½″ d; phosphor bronze silver pl cont; 1.58″ diam chassis hole, grooved to fit 0.090″ panel (2Z8654.7)	Amphenol type S8TM	3300-295840500 CUI		2
42	243	SWITCH, rotary: 12 pole 3 position; silver pl brass cont; bakelite body; 1¾″ lg x 1⅞″ h x 1½″ wd; shorting type cont; solder lug term; single hole mtg, bushing ⅜″-32 x ¼″ lg, shaft ¼″ diam x ¾″ lg, surface mtg (3Z9825-32)	Bendix C58583	3300-395436000		1
43	254	SWITCH, rotary: 12 pole 3 position; silver pl brass cont; bakelite body; 1½″ lg x 1⅞″ h x 1½″ wd; shorting type cont; solder lug term; single hole mtg, bushing ⅜″-32 x ¼″ lg, shaft ¼″ diam x ½″ lg, surface mtg (3Z9825-33)	Bendix C58584	3300-395438000		1
44	258	TRANSFORMER, AF: line type; pri 12,500 ohms impedance, secd 600 ohms impedance, 1500 v RMS test; encl steel case, steel core; 1⅞″ lg x 1 7/16″ wd x 2 3/16″ h; 1 w operating level; turns ratio 4:56:1; freq response 300-3000 cyc ± 3 db; 5 screw type term on bottom; four No. 6-32 tapped holes on 1⅜″ x 1″ mtg/c (2Z10000-10)	Bendix A103058	3300-297737500	1	1
45	231	TRANSFORMER, IF: 12 mc; 1st IF; shielded; 3⅝″ lg x 2″ wd x 1 17/32″ h; powdered iron core; tuned pri and secd; adj iron core; two No. 6-32 screws on 1⅞″ mtg/c; 4 solder lug term on bottom and 2 flexible leads from side (2Z10001.2)	Bendix AL73530-1	3300-297766000		1
46	234	TRANSFORMER, IF; 12 mc; 4th IF; shielded; 3 11/16″ lg x 2″ wd x 1½″ h; powdered iron core; tuned pri and secd; adj iron core; two No. 6-32 screws on 1⅞″ mtg/c; 4 solder lug term on bottom (2Z10001.8)	Bendix AL73028-1	3300-297775000		1
47	275	TUNING UNIT, RF: mixer and 1st IF; p/o Sig C Radio Receiver BC-639-A; c/o 4 coils, 14 capacitors and 9 resistors; freq 11.9 to 12.1 mc, 10 mw output; 5 7/16″ lg x 4⅞″ h x 2 7/16″ wd; mts in metal cabinet (2C4439A/A1)	Bendix AN-91050-1	3300-217254000		1
48	VT-152	TUBE, electron: power amplifier pentode (2J6K6GT/G)	JAN-6K6GT/G	3300-234580500	1	10

Item No.	*Reference Symbol*	*Description of Part*	*Mfr Part No.*	*AAF Stock No.*	*Spare Qty*	*Maint Qty*
49	VT-211	TUBE, Electron: RF pentode (2J6SG7Y)	JAN-6SG7	3300-234700000	3	20
50	VT-103	TUBE, electron: duplex diode, high-mu triode (2J6SQ7)	JAN-6SQ7	3300-234760000	1	10
51	VT-202	TUBE, electron: UHF midget triode (2J9002)	JAN-9002	3300-235835000 CUI	1	10
52	VT-203	TUBE, electron: UHF midget remote cutoff pentode (2J9003)	JAN-9003	3300-235840000 CUI	3	40

REVIEW OF FINAL EXAMINATION

Display both the block diagram and the schematic diagram of the receiver. Using the examination, review each question and give the correct answer. Answer in detail the questions which cause the students difficulty. At regular intervals allow the students to ask questions of their own, and to engage in classroom discussions pertaining to those questions.



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